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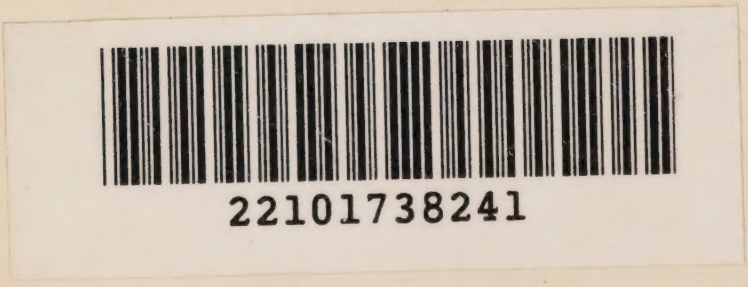

To Lord Lister.

With Alfred Killick
Compliments.

30 Wimpole St:
London W.
July 1901.

In Reading
Vide P. 105. Milk as a means
of producing Tetes Mesenterica
in infants? also P. 107.

TUBERCULOSIS

SECTION OF LUNG SHOWING CASEOUS TUBERCULOSIS, ACUTE BRONCHO-PNEUMONIC TYPE.

(*After the Plate in "La Phtisie Pulmonaire."*)

FRONTISPIECE.

SECTION OF LUNG SHOWING CASEOUS TUBERCULOSIS, ACUTE BRONCHO-PNEUMONIC TYPE.

(*a*) Recent cavities.
(*b*) Cavities opening into bronchial tubes.
(*c*) Septum.
(*d*) Fresh tubercular caseating nodules.
(*e*) Pneumonic infiltration.
(*f*) Bronchus.

In the upper lobe are seen lobules of lung, which are almost completely destroyed by caseation and cavities, and of which little more than the periphery remains.

In the lower lobe, at the upper part, a group of lobules is seen already in course of destruction; at the lower part are fresh tubercular nodules, surrounded by extensive pneumonic infiltration.

L.H.2

TUBERCULOSIS

ITS NATURE, PREVENTION, AND TREATMENT

WITH SPECIAL REFERENCE TO

THE OPEN AIR TREATMENT OF PHTHISIS

BY

ALFRED HILLIER, B.A., M.D., C.M.

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Physician

WITH THIRTY-ONE ILLUSTRATIONS AND THREE COLOURED PLATES

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PREFACE.

TUBERCULOSIS offers many aspects for study. These have been considered under different headings and in many different volumes; but no one book in English, so far as I am aware, is devoted to the subject as a whole. Thus, prevention is dealt with by various treatises on public health, the micro-pathology of the disease by works on bacteriology, the clinical forms by works respectively on surgery and on medicine; while the latest development in treatment has itself been the subject of several publications. For this reason I venture to believe that a concise manual, dealing with all the hydra heads of Tuberculosis in one volume, will form a work of reference of some interest and value to practitioners of medicine and medical students. It is for them that this work is primarily intended. The chapters dealing with prevention in every-day life, as well as by legislation and public action, may have some interest for members of local bodies who directly and indirectly exercise control over sanitation and public hygiene, and I hope that my advocacy of the more extended use of the tuberculin test in cattle will receive some attention at the hands of agriculturists.

In Chapter V. I have embodied a good deal of a paper on the "Prevention of Tuberculosis" which I contributed to the *British Medical Journal* last autumn, and in Chapter VII. a portion of an

article of mine which appeared in the *Practitioner* in August, 1899.

In preparing this volume I have received valuable advice and assistance from Dr. Newman, Assistant Bacteriologist at King's College; Dr. Hector Mackenzie, Senior Assistant Physician to the Brompton Hospital; and Dr. Archer Brown. I am also indebted for encouragement and suggestions to Mr. Malcolm Morris, Editor of the *Practitioner*, and Professor Sims Woodhead. At the Brompton Hospital I have seen a large number of the in-patient and out-patient consumptives during the past year, and must express my obligation for the courtesy shown me by various members of the staff, more particularly by Dr. Acland and Dr. Habershon. Professor Liebmann rendered me valuable assistance in the perusal of the works of several German authors.

Tuberculosis is the Nemesis of overcrowding, of squalor, of departure from the conditions of a healthy animal life. Immunity from Tuberculosis is a large portion of the reward which a community may hope to derive from good sanitation, from light, from air, from all that is sound in the progress of civilisation, and all that is conducive to the material and moral welfare of the masses. It is thus a Social as well as a Medical Problem.

ALFRED HILLIER.

30, *Wimpole Street, London, W.*
March, 1900.

CONTENTS.

CHAPTER I. PAGE

NATURE OF TUBERCULOSIS.

Introductory—Tuberculosis in Animals—Etiology of Tuberculosis —The Researches of Koch—The Tubercular Nodule—Microscopic Appearance of the Bacillus and its Spores—Examination of Sputum—Mounting and Staining—Observations on the Life of Tubercle Bacilli outside the Body of a Host—Channels of Communication of the Disease—Geographical Distribution of Tuberculosis—The Influence of Race, Sex, and Age on the Incidence of Tuberculosis 1

CHAPTER II.

THE DIFFERENT CLINICAL FORMS OF TUBERCULOSIS.

Histology and Morbid Anatomy—Congenital Tuberculosis—Acute or Miliary Tuberculosis—General, Pulmonary, and Meningeal Forms—Tuberculosis of Lymph Glands—General—Cervical, Mesenteric, and Bronchial—Pulmonary Tuberculosis—Acute Phthisis or Caseous Tuberculosis of Lungs—Pneumonic and Broncho-pneumonic Types—Chronic Phthisis—Fibro-Caseous and Fibroid Forms—Tuberculosis of the Serous Membranes—Peritoneal, Pleuritic, and Pericardial—Tuberculosis of Brain and Spinal Cord—The Alimentary System—The Intestines—The Liver—Tuberculosis of Genito-Urinary System—Kidneys, Bladder, Testes—Tuberculosis of Joints, Bones, and Muscles—Cold Abscess—Tubercular Teno-Synovitis—The Integumentary System—Tubercular Ulcer—Lupus Vulgaris—Tubercular Affections of the Eye 20

PAGE

CHAPTER III.

TRANSMISSION FROM MAN TO MAN.

Heredity—Congenital Tuberculosis—Inherited Susceptibility—Communicability—The Sputum of the Consumptive—Recorded Cases of Communicated Phthisis—The Viability of Tubercle Bacilli in Sputa—Ransome's Researches—Paths of Invasion: Inoculation, Ingestion, Inhalation—Auxiliary Forces of Invasion: Adenoids, Measles, Catarrh, Trauma—Recapitulation . 79

CHAPTER IV.

TRANSMISSION FROM ANIMALS TO MAN.

Tuberculosis in Cattle—The First Royal Commission on Tuberculosis—Its Report—Experiments of Experts with Tuberculous Meat—Testimony of Sidney Martin and Sims Woodhead—The Relative Prevalence of Tuberculosis in Different Food Animals—The Second Royal Commission—Tuberculosis in the Pig—In Sheep—Avian Tuberculosis—Cow's Milk—Tuberculous Disease of the Udder—Recorded Cases of Tuberculosis in Children from the Ingestion of Tuberculous Milk—The Relation of Tuberculosis in Milch Cows to Tabes Mesenterica in Children—The Absence of both in Jersey—Protection against Virulent Milk—Paths of Invasion in Man and Animals from Ingested Food containing Tubercle Bacilli 95

CHAPTER V.

PREVENTION IN EVERY-DAY LIFE.

The Possible Sources of Danger—Dust in Houses, Public Buildings, Railway Carriages—Modes of Removal—Conditions Required in a Healthy House—The Flower and the Fungus—Ventilation—Light—The Treatment of Milk, Butter-Milk, Skimmed Milk, and Cream—Butter and Cheese—Meat—Susceptibility to Infection—Inherited Susceptibility—Acquired Susceptibility—Atmospheric Impurity and its Different Forms—Soil—Observations of Ransome and Buchanan—The Care of Children—Herbert Spencer's Advice to Parents—Distinction between Fresh Air and Exposure—The Hardening Theory—Liebig on Food and Clothing—Precautions Necessary with the Consumptive—Control of the Sputum—The Pocket Spittoon an Essential—Spitting 111

PAGE

CHAPTER VI.

Prevention by Legislation and Public Action.

The Present Laws offer no Protection against Tuberculosis—Should they not do so?—The Second Royal Commission on Tuberculosis—Extent of Tuberculosis in Dairy Stock—Inspection of Meat—Varying Practice and Standards—Public Health Acts—Ludicrous Qualifications of Meat Inspectors—"Chaos is the only Word"—Necessity for Skilled Meat Inspectors—Public Slaughter-houses—The Scotch is the best and most efficient Public Health Act—Abuse of Private Slaughter-houses—Practice in the best Continental Abattoirs—Compensation to Owners of Condemned Carcases—Insurance, Contribution from Local Authorities—Milk Supply—Local Authorities Powerless to Prevent the Sale of Milk drawn from Diseased Cows—Tuberculous Disease of the Udder—The Recommendations of the Commission—Notification of Udder Disease: a totally Inadequate Measure—No Tuberculous Animal should be Allowed to Remain in a Dairy—Isolation, not Destruction—What might be done with the Milk of Reacting Cows—The Australian Colonies have Solved the Problem—Notification of Phthisis: Compulsory or Voluntary?—Factory Acts—Housing of the Working Classes Act—Paris behind London—Lord Rowton and Rowton Houses—The Airing of Cities . . . 130

CHAPTER VII.

Treatment of Tuberculosis.

Spontaneous Healing of Tubercular Foci—Caseation *v.* Sclerosis—Open-Air Treatment—Tuberculosis an Indoor Disease—Evidence from the Animal Kingdom—Absence of Catarrh in Open Air—The Action of Pure Air on the Consumptive—The Toxic Qualities of Respired Air—Observations of Paul Bert, Brown-Séquard, D'Arsonval, and Others—The Toxic Respiratory Impurity an Effete Animal Product on which, when re-absorbed into the Tissues, the Vegetable Tubercle Bacillus Flourishes—Wind, Rain, and Fog—Ventilation and Draughts—Temperature of Rooms—Ocean Voyages a Lottery—The Stuffy Cabin—High Phthisis Rate in French Navy and English Training Ships—High Altitudes—Dry Climates—Veld Life—Kimberley Sanatorium—Sanatoria for the Treatment of Consumption—Görbersdorf—Falkenstein—Nordrach, and the

PAGE

Nordrach *Régime*—The Grabowsee—Portable Huts—British Sanatoria—Results at Different Sanatoria—In Germany—In Great Britain—Requirements of a Sanatorium—London Open-Air Sanatorium—Principles of Treatment in a Sanatorium—Daily Routine—Walking Exercise—Febrile Cases—Pocket Spittoons—Open-Air Treatment in Private House—Cases of Tuberculosis in General and Special Hospitals—Treatment of Special Symptoms: Fever, Hæmoptysis, Pain in Tubercular Meningitis—Sweating—Cough—Dyspepsia—Diarrhœa—Specific Treatment—Tuberculin, T. O. and T. R.—Surgical Treatment 157

CHAPTER VIII.

National Movements against Tuberculosis.

In Germany—Sanatoria—France—Œuvre de la Tuberculose—Spittoons in Public Schools—Separation of Consumptives in Hospitals from other Patients—Ligue contre la Tuberculose—United States—Board of Health in New York—Practical Measures Adopted—Diminution in Phthisis Rate—Australia—Great Britain—National Association for the Prevention of Tuberculosis 217

APPENDIX 225

LIST OF ILLUSTRATIONS.

PAGE

FRONTISPIECE.—Section of lung showing caseous tuberculosis.

PLATE I.—Pneumococci and tubercle bacilli . . . *To face* 16

PLATE II.—Section of lung showing old cavities and tubercular granulations . . . . . ,, 38

Tubercle bacilli and some epithelial cells in sputum 14

Tubercular nodule 21

Bacilli in tubercle in human lung, showing (*a*) giant cell and (*b*) peripheral arrangement of bacilli inside it 35

Incipient tuberculous endo-bronchial inoculation. (*a*) Nodule laid open. (*b*) Atelectasis of lobule beyond (after Birch-Hirschfeld). 41

Cast of bronchial tree in fusible metal. Front view of left lung (after Birch-Hirschfeld) 57

Brehmer's Sanatorium, Görbersdorf 75

The Falkenstein Sanatorium 93

Tubercle bacilli in cat's lung 104

Shelters in the woods. Dr. Brehmer's Sanatorium, Görbersdorf . 115

Sputum bottles 128

Map of England and Wales, showing proportion of deaths from phthisis 139

Rowton House, Hammersmith Road, W. 150

Two cubicles in Rowton House, Hammersmith Road, W. . . 155

High veld at the foot of Maluti Mountains, Basutoland, South Africa—winter 163

Up-country town, South Africa 171

The Kimberley Sanatorium, South Africa 174

Open-air shelter with movable glass panels 176

PAGE

Shelter for exposed spot, with glass doors on all sides . . . 177
Part of Nordrach Sanatorium, in the Black Forest 181
Interior of the Liege-halle at the Falkenstein Sanatorium . . 183
Red Cross Döcker huts, Grabowsee Sanatorium 187
Döcker hut used as a Liege-halle, Grabowsee Sanatorium . . 188
Liege-halle in Dr. Weicker's Krankenheim in Görbersdorf . . 193
Rest cure in summer, Albertsberg Sanatorium 195
Rest cure in winter, Albertsberg Sanatorium 197
Different forms of open-air shelters 200
Sheltered verandah and balcony 202
Sun-trap, for use in garden of private house 207
Mundesley Sanatorium, south front 211

TUBERCULOSIS.

CHAPTER I.

NATURE OF TUBERCULOSIS.

Introductory—Tuberculosis in Animals—Etiology of Tuberculosis—The Researches of Koch—The Tubercular Nodule—Microscopic Appearance of the Bacillus and its Spores—Examination of Sputum—Mounting and Staining—Observations on the Life of Tubercle Bacilli outside the Body of a Host—Channels of Communication of the Disease—Geographical Distribution of Tuberculosis—The Influence of Race, Sex, and Age on the Incidence of Tuberculosis.

OF all diseases which have wrought devastation among mankind there has never been a disease more deadly, more persistent, or more widespread, in one or other of its many clinical forms, than Tuberculosis. It is estimated that a million lives annually are lost by it throughout Europe; and in England and Wales alone its death roll is close upon 60,000. Other communicable diseases have caused more dismay, more panic, and occasionally and for short periods even wider destruction; but Tuberculosis has been, until recently, unrecognised among the other contagions, the most constant and most virulent of all.

That the true character of Tuberculosis should have escaped detection so long seems remarkable, but when the insidious nature of the disease, and the subtle character of the bacillus, come to be studied, astonishment at its non-detection is replaced by wonder at the hardy characters, and the history so long secret, of this impartial parasite.

Over 200 years ago the Plague swept through London a whirlwind of pestilence, and then left the city, as swiftly almost as it had come, a city of mourners. The horror and the terror of it remain with us to this day. The disease spread from house to house. Death stalked in the narrow streets. Men and women fled or shut up their windows as the corpse passed by. Here was a contagion, an infection, that all might comprehend. Death claimed 50,000 victims.

And if our forefathers had cause to dread the Plague, they had good reason also to shun and fear smallpox. There was little doubt about its infectious character. Wherever it found its way it rapidly spread, as it spreads to-day, wherever mistaken and false sentiment is allowed to prevent vaccination. In the same category must be classed scarlet fever and measles, and all the other infectious diseases. And now there comes to be added to this list the most familiar and fatal disease of all, the one which men thought was handed down from one generation to another, an unwelcome heritage; the ill of all others that flesh was heir to, tuberculosis. And yet if we accept for the terms "infectious" and "contagious" the connotation which they bore in the not so very remote times of pre-bacteriological pathology, and which they still bear in the minds of some writers, we must recognise that tuberculosis is, in a sense, neither the one nor the other. For with the term "infection" was undoubtedly involved the idea of volatile and readily conveyed virulent living or dead matter emanating directly and immediately from the body or excreta of the patient, and transmitted through the air to some fresh subject; while the term "contagion" implied a still greater degree of danger of transmission from actual contact.

So strongly has the anomaly of these terms, as

applied to tuberculosis been felt by certain American writers, that the wider and less misleading epithet of "communicable" is used in describing the character of the disease. "Communicable" has this further advantage, that if the true significance which bacteriological research attaches to the terms "infectious" and "contagious" be accepted, it includes both.

But let us use what epithets we may, this fact at least is certain, that tuberculosis stands to-day revealed as one of a virulent host of human scourges due to micro-parasitic origin, and the most deadly of them all.

Tuberculosis is a compound term which includes all the pathological changes caused by the tubercle bacillus in animal tissues.

The actual classification of diseases is liable to modification as knowledge of their etiology is gradually extended. "Tuberculosis does not belong in its pathological effects to the group of acute infectious diseases which kill by acute toxæmia, but to the group known as the 'infectious granulomata,' to which syphilis, actinomycosis, and leprosy also belong, and which destroy life not only by the chronic and long-continued systematic poisoning they produce, but by the pathological changes brought about through the localisation and growth of the germs in organs necessary to life." * This is an admirable description of the nature of the morbid processes produced by tuberculosis in man. But in relation to "infection" tuberculosis stands almost midway between the acute infectious diseases and the other granulomata. The precise character of its communicability will be considered in subsequent pages.

Tuberculosis has been recognised from a very early date, and interesting references to it may be found in the pages of several classical writers.

* Trudeau and Baldwin.

Columella, a writer of the first century, a native of Gades (Cadiz), writes in his best-known work, "De Re Rustica," of a disease in cattle which Nocard* declares to have been tuberculosis: "Est etiam illa gravis pernicies, cum pulmones exulcerantur, inde tussis et macies, ad ultimum phthisis invadit." (Lib. vi., chap. xiv., "De Re Rustica.")

In the eighteenth century, both in Italy and Spain, phthisis was not only known but was recognised as an infectious disease, against which the most stringent precautions were taken. Thus Nocard writes: "At Naples a royal decree, dated September 20th, 1782, ordered the isolation of consumptives and the disinfection of their habitations, goods, furniture, books, etc., with vinegar, brandy, lemon juice, sea water, fumigations, etc., under a penalty of three years at the galleys for common persons, and three years' imprisonment and a fine of 300 ducats for the first offence, and to banishment for ten years for the second, and anyone who aided the escape of a consumptive was condemned to six months' imprisonment."

And so in Spain, Georges Sand, travelling in 1839 with Chopin, "who was already attacked by the disease which carried him off ten years later, had just settled down in Majorca." "At the end of a month poor Chopin," she writes in her letters, "who had had a cough since we left Paris, became worse; we sent for a doctor—two doctors—three doctors—each more stupid than the other, who started to spread the news in the island that the sick man was a consumptive in the last stage; as a result there was great alarm. Phthisis is rare in these climates, and is looked upon as contagious. We were regarded as plague-infected, and furthermore, as heathens, as we

* Nocard: "The Animal Tuberculoses and their Relation to Human Tuberculosis." Translated by Scurfield.

did not go to Mass. The owner of the little house which we had rented turned us out brutally, and wished to bring an action against us to compel us to limewash his house, which he said we had infected. The law of the island plucked us like chickens."

The Italian law appears to have had for many years provisions against the contagion of consumption. Lord Salisbury, in his speech at Marlborough House on the occasion of the meeting held, in December, 1898, at the invitation of H.R.H. the Prince of Wales, "to inaugurate the National Association for the Prevention of Tuberculosis," said: "I remember some relations of mine just after the great war who went abroad to be cured of consumption at an Italian city, and they found there the strongest provisions of the law against their inhabiting any dwelling for such purposes from which the contagion might be expected to spread, and that after death those very provisions which Sir William Broadbent is anxious that sanitary authorities should make here, were already a matter of law and of active practice in that country."

But whatever views may have been held on this subject in Italy and Spain, the credit of having first scientifically demonstrated the inoculability of tuberculosis is attributed by Koch to Klencke, and by Nocard to Villemin.

Villemin's researches in 1865 were most thorough and complete, and he published to the world a series of experiments and control experiments, whereby he established the infectious character of the disease and the identity in origin which existed between bovine and human tuberculosis.

To Robert Koch is due the crowning honour of having in 1882 isolated the "tubercle bacillus," or, as it has been justly though undesirably called, the "bacillus of Koch."

Tuberculosis in Animals.—From the time when Villemin first established the identity in nature and origin between *perlsucht* in cattle and tubercle in man, the number of animals which have come to be recognised as subject to tuberculosis, or in other words as capable of nourishing as hosts the fungus parasite tubercle bacillus, has continually been added to—cattle, sheep, goats, pigs, the carnivora, many of the rodents, and birds, are all subject, with varying degrees of liability, to the disease, and will require a more detailed consideration when the subject of "communicability of tuberculosis from animals to man" comes to be treated in Chapter IV. The developments of the disease in animals, although all have different modifications, are in the main similar to those in man, the lymphatic glands, abdominal organs, and the lungs being the most common sites of tubercular mischief, while a disseminated tuberculosis may also occur, and almost any organ or part become affected.

THE ETIOLOGY OF TUBERCULOSIS.

For the establishment of tuberculosis in any form, as for the artificial culture of the tubercle bacillus in the laboratory, two conditions are essential, namely :—

(1.) The introduction of the bacillus;

(2.) A soil suited to the requirements of the bacillus.

Other conditions are contributory or hostile to the ultimate establishment of the disease, but these two remain paramount and essential. To prevent either or both occurring wherever possible; to minimise the contributory and strengthen the hostile conditions where the prevention of the two essential conditions has been impossible; must constitute the

guiding principles of all public and private effort against the encroachments of the disease. These principles form the only rational basis of action, either for the officers of public health or the physician who is called upon to treat the disease.

Koch conducted a series of researches into the nature and origin of tubercle in 1882, and published his results.*

Koch's researches and essay constitute a piece of scientific work unique in the present generation. Many experimenters and writers have revealed fresh facts, and contributed fresh ideas on the subject of tuberculosis since his essay was written, but the intimate pathology, the rationale of the incidence of the disease, remain as originally described by Koch practically unaltered and unassailed.

The task which Koch accomplished was to show:

1. That in all active tuberculous lesions tubercle bacilli were to be found, in some in abundance, in others sparsely. Thus in the rapidly developing tubercle they are abundant, in more chronic lymph gland and bone affections they are much more diffuse.

2. That tubercle bacilli have staining properties which distinguish them from all other bacilli. Ehrlich's method of staining was the one adopted by Koch, although later investigators have employed the Ziehl-Neelsen and other methods, which will receive consideration later (*vide* p. 15). But using Ehrlich's method, Koch discovered that only one other known form of bacillus had staining properties like the tubercle bacillus—namely, the bacillus of Leprosy. This, as he points out, is the more interest-

* "Mittheilungen aus dem Gesundheitsamte," vol. ii., 1884. This paper was translated by Mr. Stanley Boyd, and published as "The Etiology of Tuberculosis" by the New Sydenham Society in their collection of "Recent Essays by Various Authors on Bacteria in Relation to Diseases," under the editorship of Mr. Watson Cheyne.

ing in that the two diseases resemble each other both etiologically and anatomically. The two bacilli also resemble each other in form and size, but the leprosy bacillus stains by Weigert's method of colouring nuclei, while the tubercle bacillus does not. A distinction can thus be made between the two. Since the time of Koch's discovery the smegma bacillus has also been shown to have staining properties very similar to those of the tubercle and leprosy bacilli.

3. That the giant cells found so frequently in tubercular tissues have an intimate relation to the tubercle bacilli. It is true that giant cells are present in other pathological processes, but as soon as they make their appearance in a tubercle they are seen to contain tubercle bacilli, sometimes singly or in small numbers, sometimes in abundance. Thus in scrofula and fungous arthritis the bacilli occur one or two at a time exclusively in the giant cells. In tubercle of the lung and other more rapidly developing conditions the bacilli appear in greater numbers, as many as fifty occurring in one giant cell, while bacilli which have destroyed their containing giant cell are found among other cells.

Having described the above observed facts, Koch says that the presence of one or two bacilli in cells of an epithelioid character may be regarded as the first stage in the formation of tubercle. He supposes the bacilli first got there by being taken up in the tissues, or lymph or blood stream, from some pre-existing tubercular focus by wandering cells, and so carried to other parts. Whether the wandering cell, so burdened, which eventually comes to a standstill, disintegrates and leaves the bacilli to be taken up by other cells on the spot, or whether, as he thought probable, the wandering cell itself becomes transformed into an epithelioid and then a giant cell, he leaves for subsequent discovery.

It is exceedingly interesting that this process of taking up the bacilli, which have no locomotory power of their own, by the wandering cells, believed by Koch to be an essential process for the dissemination of the bacilli within the host, should at a later period have been regarded and described by Metchnikoff, under the name of Phagocytosis, as a sort of mechanism of defence with which nature has endowed the unfortunate hosts liable to invasion by micro-organic parasites. According to the phagocytic view, the wandering cells attack the bacilli and endeavour to devour or destroy them.

Metchnikoff maintains that in the marmot, an animal which is comparatively resistant to avian tuberculosis, the mononuclear leucocytes devour and digest the avian tubercle bacilli, fragments of which may be seen in the cells in various stages of degeneration.

At first sight these two theories appear in diametric opposition to one another. That the wandering cell should be a carrier, thereby supplying the tubercle bacillus with a means of locomotion and, at the same time, a destroyer of the bacillus, seems on the face of it irrational. But on further consideration one recognises that these actions of the wandering cell are not necessarily inconsistent. The leucocytes have the amæboid property of taking up any minute foreign particles with which they come in contact. Where that particle is a virulent bacillus, one of the two organisms succumbs to the physiological demands of the other. In the one case, as in ordinary bovine or human tuberculosis, the bacilli increase within the wandering cell and then absorb or otherwise destroy it, when the bacilli prevail and fresh tubercular foci are planted. In the other case, as with the marmot invaded by avian tubercle bacilli, the cell, as we have seen, digests or disintegrates the

bacillus; the leucocyte prevails. What the qualities in leucocyte or bacillus may be which produce the one result rather than the other, it is for future research to ascertain.

With regard to the origin of giant cells, which Koch suggested might be developed from wandering cells containing tubercle bacilli, later investigators have been led to believe that they are the result of the toxic action of the tubercle bacilli upon the connective tissue cells. Thus Newman,* following in part the pathology of the French school, has described how the bacilli, when once brought into the tissues, act. He says that as soon as the invading bacilli find themselves in a favourable nidus they begin to multiply. Irritation of the surrounding connective tissue occurs, producing proliferation of the connective and tissue cells and their change into larger cells known as epithelioid cells. At the periphery of the collection of epithelioid cells a congested area is found, and the tubercular nodule begins to be defined. At the centre of the nodule further changes occur in the epithelioid cells: some become fused together, whilst others expand and undergo a division of nucleus. In this manner a series of large multinucleated giant cells are produced. In active progressive disease these soon caseate and break down in the centre. In a limb there is produced a discharge, and in the lung an expectoration, both the result of a breaking down of the new cell formation. Previously to breaking down a fully developed nodule consists of healthy tissue, an inflammatory zone, epithelioid cells, and giant cells containing nuclei and bacilli. The sputum or discharge will, during the acute stage of the disease, contain countless numbers of the bacilli, which may be detected and used as evidence of the disease. It is clear that when the centre of a nodule

* "Bacteria."

degenerates and comes away as discharge a cavity will soon be formed. By degrees this cavity becomes enlarged, and by the fusion of a number of such growing small cavities a large cavity may be produced. Thus, though at the outset of tubercular disease in the lung the lung is solid, at the end it is hollow. The breaking down of a nodule is partly due to the toxins of the bacillus and partly to the cutting off of the blood supply, owing to the fact that new capillaries cannot grow in the dense nodule and the old ones are gradually occluded.

From the local foci of disease, the initial one of which in the lung is usually situated in a small bronchus (Birch-Hirschfeld), the tubercular process spreads by three channels (Fig. 4):—

(*a*) *The lymphatics.* This channel especially affects the glands, and the frequency with which bronchial, tracheal, mediastinal, and mesenteric glands are affected shows how common a channel of infection the lymphatics are. Chains of enlarged and hardened glands become formed in this way both in animals and man.

(*b*) *The blood-vessels.* The invasion of the blood stream accounts for the cases of general miliary tuberculosis, as when a caseating gland or other structure ruptures into a blood-vessel.

(*c*) *Continuity of tissue.* Instances of this occur when infective giant-cell systems encroach upon neighbouring tissues, and when discharge from lungs or bronchial glands passes into the gullet and sets up disease of the intestinal tract. The systems principally affected by the tubercle bacillus in this way are the respiratory and alimentary.

Where the bacilli are arrested under favourable conditions of tissue soil, they proliferate and excite the formation of granulations, or miliary tubercular nodules. These increase and coalesce. The lymph

glands which drain the lymph from the affected area are first affected, and appear to arrest the march of invasion, each gland acting as a barrier to progress until its structure is broken down. The disease remains local, in spite of increase in number and importance of foci, as long as the bacilli do not actually get into the blood stream.

Koch further states in the Essay referred to:

4. That the tubercle bacilli have the power of spore formation. The spores, like those of other bacilli, are difficult to stain. They are oval, bounded by a fine-coloured line. From two to six are usually found in a single bacillus.

Since Koch first described these oval forms occurring in the bacillus as spores a good deal of controversy has arisen on the subject, and the generally accepted view now is that these oval forms are really vacuoles, and evidence of retrogressive metamorphosis, and not spores at all. Flügge has described similar light spots in other bacilli. Roux, Metchnikoff, and Nocard had their attention drawn to the fact that with high coloration with aniline, fuchsine, and subsequent discoloration in single bacilli, there appeared small round bodies going from dark to black, which gave them a grain-like appearance, and which they believed to be the true spores. Commenting on this theory, Cornet* says that if these granules be the true spores they lack the highly resistant power of most other spores, and possess only a small degree of resistance to warmth, desiccation, and antiseptics.

5. That the tubercle bacilli may be cultivated and sub-cultivated on suitable media under requisite conditions outside the body. Attempts to cultivate the tubercle bacillus on ordinary media having failed, Koch eventually succeeded with blood serum pre-

* "Die Tuberculose."

pared by a method devised by himself and carefully described in his treatise.

6. That inoculations with tubercle bacilli, even after many generations of sub-cultivation on blood serum, produced in various species of animals tuberculosis characterised by lesions, which, in their turn, yielded tubercle bacilli.

7. That no other matter than that containing tubercle bacilli, or than the pure tubercle bacilli themselves, could, when inoculated into any animal, produce tuberculosis.

Later researches of Koch published in 1897 have shown, however, that dead tubercle bacilli, although they cannot produce tuberculosis, do, when injected into rabbits, set up a local toxic action, and even inflammatory changes, similar to those produced by living tubercle bacilli.

From Koch's brilliant researches and the conclusions deduced therefrom, as well as from all subsequent investigations and statistics, it is abundantly clear that the tubercle bacillus is the *fons et origo mali.*

Microscopic Appearances of the Tubercle Bacillus and its Spores.—Tubercle bacilli appear under the microscope as delicate rods or threads. They are usually about 1·5 μ to 5 μ in length, ·2 μ in thickness; thus, in proportion to their length, they are comparatively thin organisms. The minuteness of these organisms will be realised when it is stated that the length of the tubercle bacillus is only about a quarter the diameter of a red blood corpuscle, and that the diameter of a red blood corpuscle averages about $\frac{1}{3500}$th of an inch.

The bacilli are often slightly curved, sometimes even (Sims Woodhead) slightly sinuous or spiral. They may be arranged in pairs or placed end to end so as to contain an angle.

All bacteriologists are not quite as convinced as Koch as to the existence of spores. Muir* and Ritchie say that in such a minute organism it is extremely difficult to recognise the exact characters of the unstained points. Hence, as already stated, some observers believe these unstained points to be

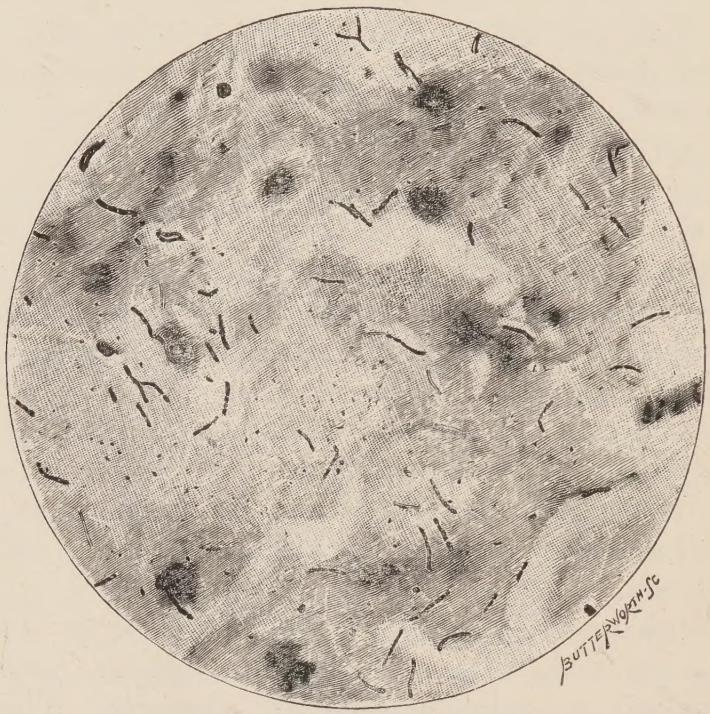


Fig. 1.—Tubercle Bacilli and some Epithelial Cells in Sputum. x 1,000. Vacuoles appear in some of the bacilli.

spores, while others consider them to be merely vacuoles. The balance of evidence, from analogy, and on biological grounds, appears to the writer to strongly favour the view that spores exist, although whether the unstained points observed by Koch were vacuoles or not future research must decide. Koch states that spore-bearing bacilli are often numerous in sputum, especially where caseous infiltration exists,

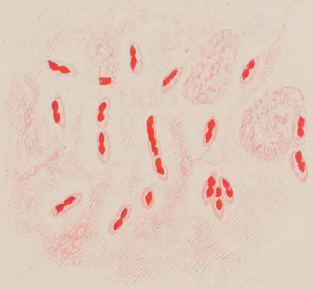
* "Manual of Bacteriology."

and the significance of this as bearing out the long-retained virulence of sputa must be borne in mind. In old cultures of the bacilli certain aberrant forms other than those described above are found. For example, very much larger elements may occur. These may be long filaments swollen or clubbed at their extremities, or they may be irregularly beaded, and may show the appearance of branching. The significance of these forms has been variously interpreted; but such morphological changes are undoubtedly of interest, in view of observations made on the altered character of the parasite in certain conditions outside the body, to which reference will presently be made. (Fig. 1.)

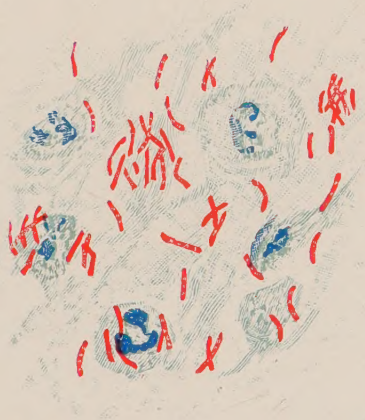
Examination of Sputum—Mounting and Staining.—The sputum is the material most frequently examined for the detection of turbercle bacilli. The best process of staining the bacilli is the Ziehl-Neelsen, and the following details require attention. Spread out the small yellow caseous-looking points of the sputum by pressure between two cover glasses. A thin film will remain on each when the glasses are slipped over each other apart. The glasses should then be dried, and passed rapidly through the flame of a spirit lamp, care being taken not to scorch the film. The cover glass should then be floated film downwards on a solution made up as follows:— Saturated alcoholic solution of basic fuchsine, 1 part; absolute alcohol or rectified spirit, 10 parts; 5 per cent. carbolic acid solution, 10 parts. This fluid is well mixed, and a small quantity filtered into a watch-glass on which the film is floated as above described. If time be an object, gently heat the fluid over a Bunsen burner or spirit lamp until steam rises; then drop the film on to the surface, and at the end of from three to five minutes the

bacilli will be well stained. If time be not an object, or if sections are to be stained, the preparation should be left in the fluid from twelve to twenty-four hours. The preparations are then transferred to a watery 25 per cent. solution of sulphuric acid, when the pink rapidly becomes a yellowish-brown tinge. When the decolorisation is complete, there should be no return of the pink on plunging the specimen into a bowl of water to which a drop of ammonia has been added; it may be necessary to return the specimen once or twice to the acid before this end is attained. After thoroughly rinsing in this slightly alkaline water, the specimen should be counter-stained in a watery solution of methylene blue. It should then be washed in water, carefully dried, and mounted in Canada balsam. The bacilli may now be seen under the microscope standing out as bright red rods in a blue background of débris, pus corpuscles, and cells. (Plate 1, *b*.)

Observations on Life of Tubercle Bacilli outside the Body.—Although since the time of Koch's first discoveries not much has been added to our knowledge of the actual etiology of tuberculosis, other investigators have been diligently at work to try and learn more of the history of the parasite outside the human or other animal host, and on this point some valuable observations have been made. Thus, Nocard, Roux, and Sir Hugh Beevor, as the results of numerous experiments, are inclined to believe that the tubercle bacillus may, under certain conditions, like the bacillus of typhoid or cholera, gradually accustom itself to a more saprophytic existence, during which period it grows more luxuriantly and is more resistant, while at the same time it loses some of its virulence; but this theory requires more evidence than has hitherto been adduced.



(*a*) Pneumococcus (Fraenkel's) in sputum, from case of acute pneumonia. Stained Ziehl-Neelsen, fuchsine; decolorised in weak acetic acid; × 1,000.



(*b*) Tubercle Bacilli in sputum, from case of phthisis, × 1,000. Stained by the Ziehl-Neelsen process.

(*After an Original Drawing by Richard Muir.*)

PNEUMOCOCCI AND TUBERCLE BACILLI.

The researches of Ransome * included a series of experiments which went to show how polluted atmospheres, especially those polluted by overcrowding, absence of sunlight and impure damp subsoils, favour the culture of bacillus, *or at least "the preservation of its virulence."* These researches and the practical conclusions to be drawn therefrom are of such interest and importance that further reference will be made to them in Chapter III.

Certain well-established characters of the tubercle bacillus, such as its slow growth under cultivation, its resistance to staining, and its retention of the stain when once it is effected, a property which it shares with spores, together with its tenacity of life within the host, and the chronic nature of the disease it excites, all seem to suggest a probable hardihood and resistance to destruction outside the host.

Communication of the Disease.—Tuberculosis is conveyed from man to man and from animals to man, but in both instances—and this is the point of such profound interest and moment, and the one which is arousing the attention and action of the civilised world—the channels by which the bacilli are conveyed are accessible and controllable. From tuberculosis in man the sources of danger are the sputa, secretions or discharges, and excrement ; in animals, meat, milk, and to some extent the excrement. These various channels will be fully considered in subsequent chapters.

GEOGRAPHICAL DISTRIBUTION OF TUBERCULOSIS.

If the zoological distribution is wide, the geographical is equally so.

Tuberculosis exists in every country, and is most intense in centres where the population is thickest.

* Weber-Parkes Prize Essay for 1897.

Climate as affected by mere latitude does not seem to have any influence on the disease, and the death-rates from phthisis as given by Lombard are in Milan 132, in Rome 114, and in London 121 per thousand deaths. According to this same authority St. Petersburg has 151 and Lima in Peru 171 per 1,000, so that latitude, so long supposed to be of such importance, is shown to have apparently no effect. Altitude, on the other hand, appears to be a much more potent factor, and in the Alps, the Andes, and the interior plateaux of Mexico and South Africa the disease is extremely rare. The difference both in the occurrence of fresh disease, and the influence on persons already suffering from tuberculosis, is strikingly shown in this respect in South Africa, where on the coast a certain amount of tuberculosis occurs and phthisical patients do not, as a rule, improve, while at the same latitude on the interior plateaux, some 3,000 to 4,000 feet higher, a fresh case of tuberculosis is rare, and the effect on phthisical patients is usually highly beneficial.

Soil is a factor almost as important as altitude, and will be considered later.

Other conditions influencing tuberculosis are *race*, *sex*, and *age*.

Race.—On the influence of race the evidence is not very conclusive, although the coloured races when brought into cities seem unusually liable to attack. If, however, the sanitary conditions of native quarters in colonial towns, which have come under the observation of the writer, be taken into consideration, it is doubtful if any reliable influence with regard to race can be drawn. The Aryan races all seem equally liable, while the intermingled Spanish and American races of Lima and Rio Janeiro have, according to Lombard, about the some phthisical mortality as obtains at Christiana or Athens.

Sex.—With regard to sex, the Registrar-General's returns from 1881 to 1890 are 1,609 females to 1,847 males per million living. But, as Ransome points out, other circumstances than that of sex govern this mortality.

Age.—Congenital tuberculosis is almost unknown. Under five years the organs other than the lungs are chiefly affected. In youth and middle age phthisis is the most common form of the disease, from the age of twenty-five to thirty-five years being the most fatal decade—in fact, nearly half the deaths occurring in England at that stage of life are due to pulmonary tuberculosis. Pulmonary tuberculosis is the disease of all others which cuts men and women down in the flower of their lives. It occurs less commonly in later life, but may do so even in extreme old age. In the decade 1881-90, 118,508 persons died of this disease between the ages of 25 to 35, out of a total of 307,550 deaths. Dr. W. Ogle gives the phthisis rate per million, at 75 years and upwards, as over 500.

CHAPTER II.

THE DIFFERENT CLINICAL FORMS OF TUBERCULOSIS.

Histology and Morbid Anatomy—Congenital Tuberculosis—Acute or Miliary Tuberculosis—General, Pulmonary, and Meningeal Forms—Tuberculosis of Lymph Glands—General—Cervical, Mesenteric, and Bronchial—Pulmonary Tuberculosis—Acute Phthisis or Caseous Tuberculosis of Lungs—Pneumonic and Broncho-pneumonic Types—Chronic Phthisis—Fibro Caseous and Fibroid Forms—Tuberculosis of the Serous Membranes—Peritoneal, Pleuritic, and Pericardial—Tuberculosis of Brain and Spinal Cord—The Alimentary System—The Intestines—The Liver—Tuberculosis of Genito-Urinary System—Kidneys, Bladder, Testes—Tuberculosis of Joints, Bones, and Muscles—Cold Abscess—Tubercular Teno-Synovitis—The Integumentary System—Tubercular Ulcer—Lupus Vulgaris—Tubercular Affections of the Eye.

Histology and Morbid Anatomy.—The "tubercle" produced by the tubercle bacillus is not in appearance peculiar to tuberculosis; the actinomyces and strongylus parasites produce very similar growths.

Newman's account of the formation of the tubercule has already been given on page 10. Baumgarten describes the process as follows:—

There is a multiplication of fixed cells, more particularly those of connective tissue and the endothelium of the capillaries; and from them polygonal rounded bodies with nuclei are produced, and described as epithelioid cells. From the vessels of the focus of infection, leucocytes, both polynuclear and mononuclear, are given forth. The polynuclear are rapidly destroyed, the mononuclear more slowly disintegrate.

A rarefaction of the connective tissue matrix results in a reticulum of fibres, most apparent at the margin of the growth. Giant cells are formed in some tubercles by the increase in the protoplasm. They frequently contain bacilli. The appearance of

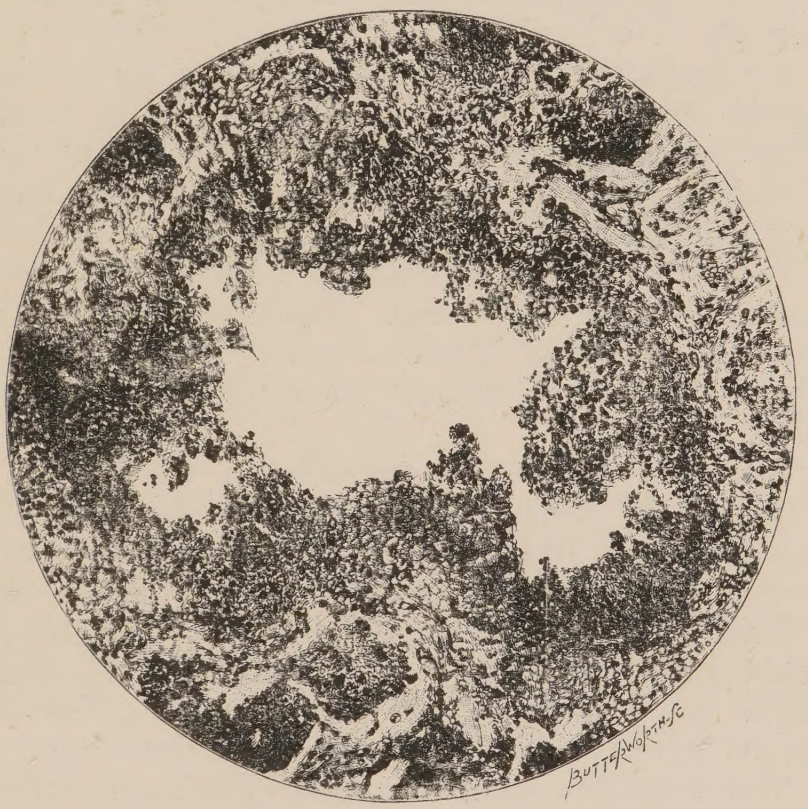


Fig. 2.—Tubercular Nodule. x 80. The microphotograph shows the minute tubercle beginning to break down.

the tubercle varies somewhat in different organs, but the process is essentially the same in all. The liver is one of the best organs in which to study the structure and development of the tubercle, as in it the growth is not complicated by numerous catarrhal changes, such as occur in the lung. The nodules are first seen as "small grey or caseous granulations, either in the capsule itself or near the surface

of the liver."* The nodule, however, soon loses its grey colour, for as soon as the growth has become fully developed it is non-vascular, and rapidly becomes first caseous and then bile stained. After the tubercle is once formed, its blood-vessels vanish, and two processes ensue—those of caseation and sclerosis.

Caseation.—The necrosis, following on an interference with the blood supply, and direct bacillary action, which occurs at the centre of the nodule, is the initial stage of caseation. Proceeding outwards from this centre the nodule gradually becomes of a yellowish colour throughout. Blood-vessels are absent, and fused together. These yellowish nodules form cheesy, often fused masses, which may either soften still further, become encapsuled with a fibroid lining, or calcify.

Sclerosis implies an increase in the fibroid elements which frequently accompanies caseation; and when necrosis in the centre of the nodule has not proceeded beyond a sort of hyaline stage which precedes actual caseation, the tubercle becomes converted into a hard, firm structure. This type of nodule is common in the peritoneum. The fibro-caseous variety often also occurs in the lungs.

The sclerotic condition, with or without calcification, is the one that supervenes in all healing tubercular lesions. Cicatrisation is Nature's remedy for repairing lesions in the soft tissues, and is part of the healing process of a wound, whether that wound be inflicted by external violence or ulceration, or by some other internal destruction of tissue. The chronic character of pulmonary tuberculosis is often such that the two processes, caseation destructive and sclerosis healing, proceed together.

Where sclerosis triumphs, the disease is held in

* "Practical Pathology," Woodhead.

check; where caseation progresses, the patient's tissues and life are eventually destroyed. The process of fusion of tubercular nodules may go on till an entire organ is involved, and in the lung large cavities are thus formed. In addition to the tubercular nodule, and the fusion of many such nodules, there are secondary inflammatory processes excited by the bacilli, which, especially in the lung, become very extensive, producing both catarrhal and fibrinous patches of pneumonia. These secondary inflammatory processes, as well as the bacilli themselves, excite the production of cicatricial sclerotic tissue. They are also liable to be invaded by micrococci, and so broken down.

The classification of the clinical forms of tuberculosis is one by no means free from difficulty, and a careful perusal of some of the various treatises on phthisis compel the student to sympathise with Koch when, in his famous essay, he replied to the reproach that he was not paying sufficient attention to pathological anatomy by saying that his desire was to "work out the etiological relations of tuberculosis, leaving the anatomical details to pathological anatomists." While the labours of the pathological anatomist have conferred great benefits upon medicine, it must be admitted that in the pre-bacteriological age of pathology the combined efforts of the physician and pathologist presented the student with a variety of pictures of phthisis in which there was a large element of obscurity. For confirmation of this it is only necessary to refer to the text-books of writers on phthisis, almost every one of whom offers a classification, and in some cases a nomenclature, of his own. The fact is, the full effect of the brilliant researches of Koch into the etiology of tuberculosis has scarcely yet had time to be adequately expressed in the literature of phthisis, but every fresh work

written shows the influence of his teaching, and all future classification must be made with the strictest regard to the history and pathological effects of the tubercle bacillus.

One of the ablest and most scientific classifications of the different clinical forms of tuberculosis is contained in Osler's "Practice of Medicine," and as it has the further advantage of being clear, methodic, and complete, this classification, with one or two modifications, will be followed here.

CONGENITAL TUBERCULOSIS.

This is extremely rare, and only some nine or ten cases have been described.

This is entirely in accord with what obtains among cattle, and Nocard* quotes statistics from abattoirs as convincing evidence against the inheritance of the disease. Thus he states that 160,000 calves are slaughtered annually at the abattoir in Munich, and that out of their number 2 were found tuberculous in 1878, 0 in 1879, 0 in 1880, 0 in 1881, 2 in 1882.

At Lyons 5 out of 400,000 slaughtered at the abattoir were found, and at Rouen 3 out of 60,000. As Nocard very justly maintains, these figures are of especial interest to the student of human tuberculosis, as the wholesale slaughter of very young calves affords facilities of examination in regard to congenital tuberculosis which are not obtainable among infants.

ACUTE TUBERCULOSIS—MILIARY TUBERCULOSIS.

In this form of the disease tuberculosis more nearly approaches the acute infectious diseases in clinical symptoms than in any other, and the actual toxæmia produced by the bacillus appears to be more acute

* "The Animal Tuberculoses."

than in any other form of tuberculosis. The etiology of the disease was described in the *résumé* of Koch's researches given in the last chapter (p. 8). Infection in the great majority of cases is an auto-infection arising from tuberculous matter being introduced directly into the blood stream or, in more rare cases, into the thoracic duct. From tuberculous glands, bones, or lungs, or from any other tuberculous focus, ulceration into a vein may occur, and, by introducing the bacilli into the circulation, set up the disease. The tracheal and bronchial glands are perhaps the most common sources of origin, but it is not always possible to trace the course and history of the invasion. For clinical purposes miliary tuberculosis may be divided into (1) acute general infection, (2) cases with marked pulmonary symptoms, and (3) cases with cerebral symptoms.

The acute general infection closely resembles typhoid fever. The temperature is more irregular, and the characteristic typhoid spots are absent, although red spots do occur. The spots do not, however, appear in crops, and lack the characters of the typhoid eruption. Acute general tuberculosis may at any stage develop the pulmonary or meningeal form, or may terminate, without either of these being pronounced, in general torpor, coma, and death.

Pulmonary Form.—Miliary Tuberculosis of the Lungs.—While infection in acute miliary tuberculosis may arise from any breaking down of tuberculous deposit, there is little doubt that in the pulmonary form of the disease an old deposit in the lung itself is usually the focus from which the infection is derived. Thus Kingston-Fowler recorded a case* in which a caseous mass at the apex of the left lung,

* "Proceedings of the Royal Medico-Chi. Soc." Series III., vol. viii., page 48.

which had probably been encapsuled for forty years, broke down and caused death from acute pulmonary tuberculosis in twenty-eight days.

The miliary tubercles occur in large numbers through the lung, in parts previously unaffected, and also frequently throughout the pleura. The symptoms vary a good deal, though cyanosis is usually strongly marked. Cough is usually present but is not always so, and the expectoration may vary from none at all to one of a clear muco-purulent or even occasionally rusty character. Dyspnœa is usually an early symptom, and the respirations are considerably increased in number.

The temperature rises to 102° or 103°, but is irregular. The pulse is feeble and rapid. The physical signs are equally open to variation, the percussion note may be almost unaffected, it may be dull over the bases, where areas of broncho-pneumonia may develop, or it may even be hyper-resonant owing to acute emphysema. On auscultation, râles, either sibilant or fine, may be heard. Tubercle bacilli are not usually present in the sputum, as the miliary tubercle is not sufficiently advanced to caseate and break down. The spleen is enlarged and sometimes tender. Of all forms of pulmonary tuberculosis this is the most fatal, and the prospects of arrest are probably almost nil, though instances are stated to occur. In diagnosing the disease, the two most striking features to be borne in mind are cyanosis and dyspnœa; the incidence of cerebral symptoms is not uncommon, and when it occurs finally determines the true nature of the disease.

Meningeal Form.—Tuberculous Meningitis.—This is the most distressing form of tuberculosis which occurs in children. It occurs also in adults, but in them is much less common. A caseating gland in the mediastinum, or mesentery, is usually

the focus from which the infection is derived. In this disease miliary tubercles are established in the meninges, often so minute as to be almost indistinguishable to the naked eye. The smaller arteries are favourite sites for the tubercles, and they are found as nodular enlargements in the perivascular sheaths. A turbid condition of the membranes occurs, followed by a fibrinous exudation.

The membranes of the base of the brain are usually most extensively affected, and those of the cord are frequently attacked. The amount of exudation is often considerable, hence the term "acute hydrocephalus," or water on the brain, which is sometimes given to the disease.

Symptoms.—This form of meningitis, though rapidly fatal in its acute stage, has not infrequently a prodromal period of some duration. Thus the following symptoms often usher in the attack. The child is listless and unwilling to exert himself; a change in the child's character is frequently noticed, and this is a symptom so common that it should always be inquired for.* The temperature rises in the evening. Vomiting and headache then supervene, usually accompanied by constipation. The vomiting or retching have the cerebral character—that is, they occur between meals, when digestion is over and the stomach nearly empty. The pulse is usually rapid; the breathing irregular and sighing, often accompanied by gaping. The senses become abnormally acute; there is photophobia, with contraction of the pupil and a shrinking from loud noises. The child is excited, crying and often screaming while awake, and twitching incessantly when asleep. The stage of *irritation* is now fully established, and superadded to the above symptoms is often a wild, restless, incessant movement which,

* "On Disease in Children." Eustace Smith.

combined with the child's piteous cries, present the most painful clinical picture it is possible to behold. Treatment will be referred to again in Chapter VII., but as in this form of the disease there is practically no hope of cure, palliation during the acute irritative stages is urgently demanded for the sake of both the child and his friends. To withhold narcotics such as opium and chloral under these conditions is to fail to provide the only succour it is in the physician's power to offer. I have seen a large number of children suffering from tubercular meningitis, and I feel bound, inasmuch as many text-books make no mention of narcotics, while describing the condition, to emphasise the duty of relieving its intense suffering.

Following the irritative stage is a condition of coma; the child is often delirious, and when not so is dull and apathetic. Convulsions are not uncommon. The pupils from being contracted now gradually dilate or become irregular. Squinting also occurs.

The last stage is that of *paralysis*, although muscular spasms of one or both sides may occur. The eyelids are only partially closed, and the pupils fully dilated. But the child cannot be roused, and remains happily unconscious. Diarrhœa is not uncommon. The temperature is often subnormal. The pulse becomes rapid. Involuntary passage of urine and fæces now occurs, and a low typhoid condition continues to the end.

The duration of the disease is usually from a fortnight to a month. The symptoms more readily reveal the true nature of the disease than in either of the other forms of miliary tuberculosis, and are usually fairly uniform, following the stages described above. Variations, however, do occur, more especially in the temperature, which during the last stage is sometimes subnormal, sometimes hyperpyrexic in

character. In diagnosing the disease in young children, it is very important to bear in mind that cerebral symptoms are frequently due not to disease in the brain but to disease of other organs, causing sympathetic disturbance of the cerebrum. This is often a cause of incorrect diagnosis; pneumonia is constantly treated as cerebral by persons who do not examine the chest, so also is pleurisy. Both these complaints are very often comparatively latent in children.* The disease is far more rare among adults than children, and among children much more frequent from two to five years of age than in infants under a year. The etiology of the disease explains this age incidence among children. For the production of tubercular meningitis it is necessary to have a primary tuberculous caseating focus already established, and this is almost invariably situated in children in a lymph gland. There must therefore be sufficient time for the lymph gland to become affected, and hence the rarity of the disease in infants under a year. A common course of events, as will be more clearly shown in subsequent chapters, is probably the consumption of unboiled tuberculous milk producing scrofula of the cervical or mesenteric glands, then caseation and breaking down of one of these glands into a small vein, and the establishment of tubercular meningitis.

TUBERCULOSIS OF LYMPH GLANDS (SCROFULA).

In children the commonest form of tuberculosis is an affection of one or more groups of the lymph glands. These conditions may also arise in later life.

In describing the occurrence of tubercle bacilli in connection with chronic adenitis or the tuberculous

* "Diseases of Children." Thomas Hillier.

enlargement of lymph glands, Koch clearly states that the bacilli occur in much smaller numbers than in the more rapidly developing tubercular nodules, that they are found almost exclusively in the giant cells, and then only one or two at a time.

This comparatively scanty distribution of the bacilli is probably sufficient to account for the lesser virulence of material from scrofulous glands, when inoculated into the guinea-pig, than that exhibited in the guinea-pig by material from ordinary tubercle, though some experimenters have, on the ground of this more delayed and slighter action with the virus of scrofula, maintained that it is of a milder character than that of ordinary tubercle. Marfan maintains that "scrofula" in childhood confers a sort of protection against tuberculosis in later life, but the evidence adduced is far from convincing, and an unhealed focus of tuberculous adenitis is now recognised as a standing menace to the organism, from which at any time acute tuberculosis may be disseminated throughout the system. Indeed, Osler goes so far as to say that in three-fourths of the instances of acute tuberculosis the infection is derived from this source. Fortunately a tendency to spontaneous healing does exist, and the calcified remnants of mesenteric and bronchial glands occasionally found, bear witness to this result; on the other hand, the cessation of disease may be only temporary. The clinical form of tuberculous affections of the glands may be divided into:—

1. **General Tuberculous Lymphadenitis.** — A diffuse tuberculosis of nearly all the lymph glands in the body does occur, although the condition is by no means a common one. In infants this condition is sometimes found occurring by successive invasions of the different groups of glands until all or nearly all are involved. The termination is almost invari-

ably fatal either from the general cachexia produced or from the onset of meningitis.

2. **Local Tuberculous Lymphadenitis.**—Much more common are the three well-known forms of this condition—(*a*) cervical; (*b*) mesenteric; and (*c*) bronchial.

(*a*) **Cervical.**—Scrofula of the neck is the commonest form, and is the typical scrofula, or king's evil of the older writers. Children, especially of the poorer classes, are very liable to be attacked, and the disease is prevalent in the slums of cities where the air of the crowded dwellings is impure and the surroundings filthy. Various conditions may precede and accompany it, such as nasal and throat catarrhs, enlarged tonsils, and adenoid growths in the pharynx. Any one of these predisposes to attack, and a catarrhal mucous membrane, an ulcerated tonsil, or an adenoid growth undoubtedly presents an open door to the invading tubercle bacillus. The submaxillary are usually the first glands to enlarge, and constitute what are popularly known as "kernels." Their appearance should at once lead to a careful search for "adenoids," or some one of the other conditions referred to which favour the entrance of the bacillus. The enlargement of the affected glands proceeds slowly, and the tumours are at first round, well defined, and isolated, later they accumulate into knotted masses. The glands in the post-cervical triangle and over the clavicle often gradually become involved. The skin over the tumours at first remains loose and freely movable, but as inflammation and suppuration supervene it becomes adherent. Suppuration does not always occur, as the enlargement of the glands may be arrested at any period of their growth under favourable circumstances, but when it does occur abscesses are produced which, whether they burst and discharge

through a sinus or are surgically opened, are very slow in healing. Fever occurs where the growth of the glands is large and rapid. The course of the disease is a chronic one, and death only rarely supervenes on an attack. Coryza, eczema of the head, and keratitis are common accompaniments, and children suffering from the disease are usually anæmic and puny in appearance.

(*b*) **Mesenteric—Tabes Mesenterica.—Consumption of the Bowels.**—Tuberculous affection of the mesenteric glands is, if not quite so common in children as the affection of glands in the neck, considerably more fatal, and in dispensary and out-patient practice is one of the diseases continually met with. Sir William Broadbent* specially referred to tabes mesenterica as the "sad exception" to the list of tuberculous forms of disease which were diminishing in numbers. Tabes mesenterica is, in fact, actually on the increase among infants under one year of age, and this increase, both in Sir. W. Broadbent's and Sir R. Thorne's opinion, is due to the feeding of infants on unboiled milk containing the tubercle bacilli. The glands affected are those of the mesentery and retro-peritoneum, which become enlarged and caseate—or occasionally go on to suppuration or calcification. Post-mortem examinations in children who have died of other diseases frequently reveal tuberculous mesenteric glands, where the glands have become enlarged and the disease in an early stage has existed without detection. It is reasonable to suppose also that many of these incipient cases under favourable conditions recover without being detected. Experiments on animals seem to show that to get severe glandular affections the food containing the tubercle bacilli

* Meeting at Marlborough House to inaugurate the National Association for the Prevention of Tuberculosis, Dec., 1898.

must contain it in appreciable quantities and be administered over some space of time. The symptoms of the disease in children are usually an enlarged and tympanitic abdomen, often with some dilations of the superficial veins, caused by interference with the portal circulation; frequent or chronic diarrhœa, a wasted and anæmic appearance. There is generally a slight rise of temperature and considerable debility. A catarrhal condition of the bowel doubtless favours the invasion of the bacillus, and in this, as in all other forms of tuberculosis, the preparation of the soil by unfavourable hygienic and pathological agencies plays an important part in paving the way for the establishment of the disease after the actual sowing of the seed. It is difficult to make out the enlarged glands by palpation, but when the peritoneum becomes involved, as is not infrequently the case, hard nodules may be felt, and in some instances ascites occurs.

(*c*) **Bronchial Glands.**—The two main channels of entry for the tubercle bacilli are the alimentary tract and the respiratory passages. Sims Woodhead believes that the tonsils and upper part of the pharynx are, like the walls of the intestine, liable to invasion by bacilli contained in milk, which thus find their way to the cervical as well as to the mesenteric glands. The bronchial glands, however, except when they become enlarged secondarily to the cervical and supra-clavicular groups, are affected through the lungs by acting as "filters in which lodge the various foreign particles which escape the normal phagocytes of bronchi and lungs" (Osler). Among and attached to these particles tubercle bacilli are not uncommon. These glands may occasionally enlarge so much as to cause pencilled veins to appear on the thorax, and other pressure symptoms; they sometimes suppurate, and,

worst danger of all, they may form centres from which systemic infection through the vessels may be produced. A slight degree of enlargement of these glands usually causes no recognisable symptoms. In more advanced cases cough is usually present, often paroxysmal in character; and Fowler* states that "a spasmodic cough, suggestive of whooping cough, has been observed in a considerable number of cases."

Where nerve pressure of the recurrent laryngeal or pneumo-gastric occurs, an interference with the functions of the larynx or heart supervenes. Pain is sometimes present. If suppuration occurs, the abscess may burst into the trachea, a bronchus, or the mediastinum. Post-mortem observations show that in this, as in all other tubercular conditions, the progress of the disease may be arrested, sclerosis and cutaneous deposits in the glands being found.

PULMONARY TUBERCULOSIS—PHTHISIS—CONSUMPTION.

If the nomenclature of other forms of tuberculosis be varied and at times misleading, that which occurs throughout the extensive literature of the subject in relation to pulmonary tuberculosis or phthisis is doubly so.

Miliary tuberculosis of the lungs has already been described as a pulmonary form of an acute general infection with an etiology, clinical history, and physical signs which clearly distinguish it from the other forms of phthisis.

Miliary tuberculosis of the lungs is probably seldom or never primary, but is secondary to some tuberculous focus which may have existed in many instances within the lung itself. The other forms of pulmonary tuberculosis—all of which are appropriately and conveniently described under the term

* "Diseases of the Chest." Fowler and Godlee.

of "phthisis"—may be divided into acute and chronic phthisis.

Caseation is such a characteristic and important feature of the disease that a nomenclature recognising and expressing it is used by many writers.

To the terms "acute" and "chronic" exception is

Fig. 3.—Bacilli in Tubercle in Human Lung, showing (*a*) giant cell and (*b*) peripheral arrangement of bacilli inside it.

often taken on the ground that it is impossible to say where one begins and the other ends; but this is still more true of all other classifications yet suggested.

Acute Phthisis, or **Caseous Tuberculosis** of the lungs, has two distinct types: (*a*) Pneumonic; (*b*) Broncho-pneumonic.

Chronic Phthisis is (*a*) Fibro-caseous; (*b*) Fibroid. These subdivisions are distinguishable patho-

logically and clinically, although the dividing line is by no means a clear one, and two or more conditions may co-exist in the same lung. The source of the mischief in all forms is, of course, the tubercle bacillus, which, in connection with its typical lesion, the tubercle, excites infiltration and proliferation of cells, leading in varying extent to caseation, calcification, and sclerosis. The different degrees to which one, or more, of these processes obtain determine the type of the disease. Mixed infection, due to the introduction of septic micrococci, also constitutes in the stages of softening and cavity formation an important element in the disease.

Acute Phthisis, or Caseous Tuberculosis of the Lungs.—Galloping consumption is, among all the various terms applied to this form of phthisis, the most familiar, and, at least, has this to commend it —that it indicates the rapid course which the disease in this form runs. Florid phthisis, scrofulous phthisis, epithelial pneumonia, etc., are terms also used. The two types of acute phthisis are pneumonic and broncho-pneumonic, and the two together do not constitute more than 10 per cent. of the total number of phthisical cases.

(*a*) **The Pneumonic Type.**—This form is not common, and when it occurs is not infrequently taken for pneumonia. One lobe, or, in some cases, the whole lung, is affected. On section, the appearance is not unlike that of red hepatisation, although on close inspection miliary tubercles can generally be made out. A case of this type may run a very acute course terminating in less than a month; more commonly it lasts for three or four months, when caseation and cavities occur.

The onset is usually sudden, and accompanied by a rigor. The temperature rises and continues high. Dyspnœa soon sets in, with pain in the side, cough,

mucoid followed by rusty sputum, which on examination is sometimes found to contain tubercle bacilli. The physical signs are those of consolidation over the area affected, dulness on percussion, increased vocal fremitus, and suppression of the breath sounds, followed by well-marked bronchial breathing. The symptoms at this stage, unless tubercle bacilli have been found in the sputum, are absolutely those of pneumonia. But, instead of resolving, like pneumonia, about the tenth day, consolidation, in these cases, continues on into the second and third week before softening occurs, and finally, when elastic tissue and tubercle bacilli are found in the sputum, the true nature of the disease is revealed. There is little doubt that many of the cases of so-called pneumonic abscess, where cavities finally form in a lung, in which the pneumonic consolidation has not resolved, are really of this nature.

Death may occur in the first few weeks, or the case may run a course of two or three months.

(*b*) **The Broncho-pneumonic Type,** or **Caseous Phthisis,** is commoner than the pneumonic or lobar form. It is the form to which children are most liable, the lobar type occurring principally in adults.

The process begins in the smaller tubes, which become blocked with cheesy material, while the air cells are filled with the products of a catarrhal pneumonia. In children the lobules of the lung are sometimes affected by the direct contact of an enlarged tuberculous bronchial gland. (Frontispiece.)

Another form of broncho-pneumonia is that which occurs as a sequence of hæmoptysis, due to aspiration of blood and the contents of pulmonary cavities into the smaller tubes. After hæmoptysis, high temperature, dyspnœa, and the physical signs of a diffuse broncho-pneumonia set in, and the case runs a rapid course.

In other cases, again, different groups of alveoli are affected in various parts of the lung, and caseating nodules are found disseminated throughout the lung substance. The apices are the parts most commonly and extensively affected.

The symptoms, especially those attending the onset of the attack, in adults vary to a considerable extent. The patient may previously have been in good health; more frequently he has been suffering from over-exertion or indifferent general health. In some instances a hæmorrhage precedes the attack. The pulse rate becomes rapid, the temperature rises, and the respirations are increased in frequency. There is a marked loss of weight and strength.

The physical signs are not at first marked; but impaired resonance, harsh and tubular breathing, with bubbling râles, are generally developed over the affected areas, most commonly the apices. Death may occur in a few weeks; or the case may linger on for some months, when softening and cavity formation set in, with profuse sweats, rigors, and a continuous loss of weight.

In children the disease very commonly follows measles and whooping cough, or some other of the infectious diseases. The hectic flush occurs markedly in these acute cases of caseous phthisis, hence the term "phthisis florida."

CHRONIC PHTHISIS. (A) FIBRO-CASEOUS, OR ULCERATIVE PHTHISIS.

Under these heads are classed those cases which run a slower course, and proceed to softening and ulceration, with the formation of cavities following upon caseation.

They constitute by far the largest number of cases with which the physician has to deal, and are

PLATE II.

FIG. 1.—Section of a lung showing old cavities and tubercular granulations.

(*a*) Congested tissue in which granulations occur.

(*b*) Dull yellowish granulations.

(*c*) A group of small granulations with caseous pneumonia of the lobule around it.

(*d*) A cavity in course of formation by the destruction of a lobule similar to the one described in *c*.

(*e*) Branch of pulmonary artery.

(*f*) Bronchus communicating freely with a large cicatrised cavity.

In this small section of lung are thus seen simultaneously occurring caseation of tubercular nodules and the pneumonic patches around them; a cavity in course of formation, and a cavity which has healed. The close proximity of these different lesions, and their co-existence at one period of the disease, show how difficult and almost impracticable are the attempts made to divide Phthisis into the three stages of consolidation, softening, and cavity formation.

FIG. 2.

(*g*) Tubercular granulations or nodules.

(*h*) A cavity the walls of which are surrounded by tissue in a condition of pneumonic caseation.

FIG. 3.

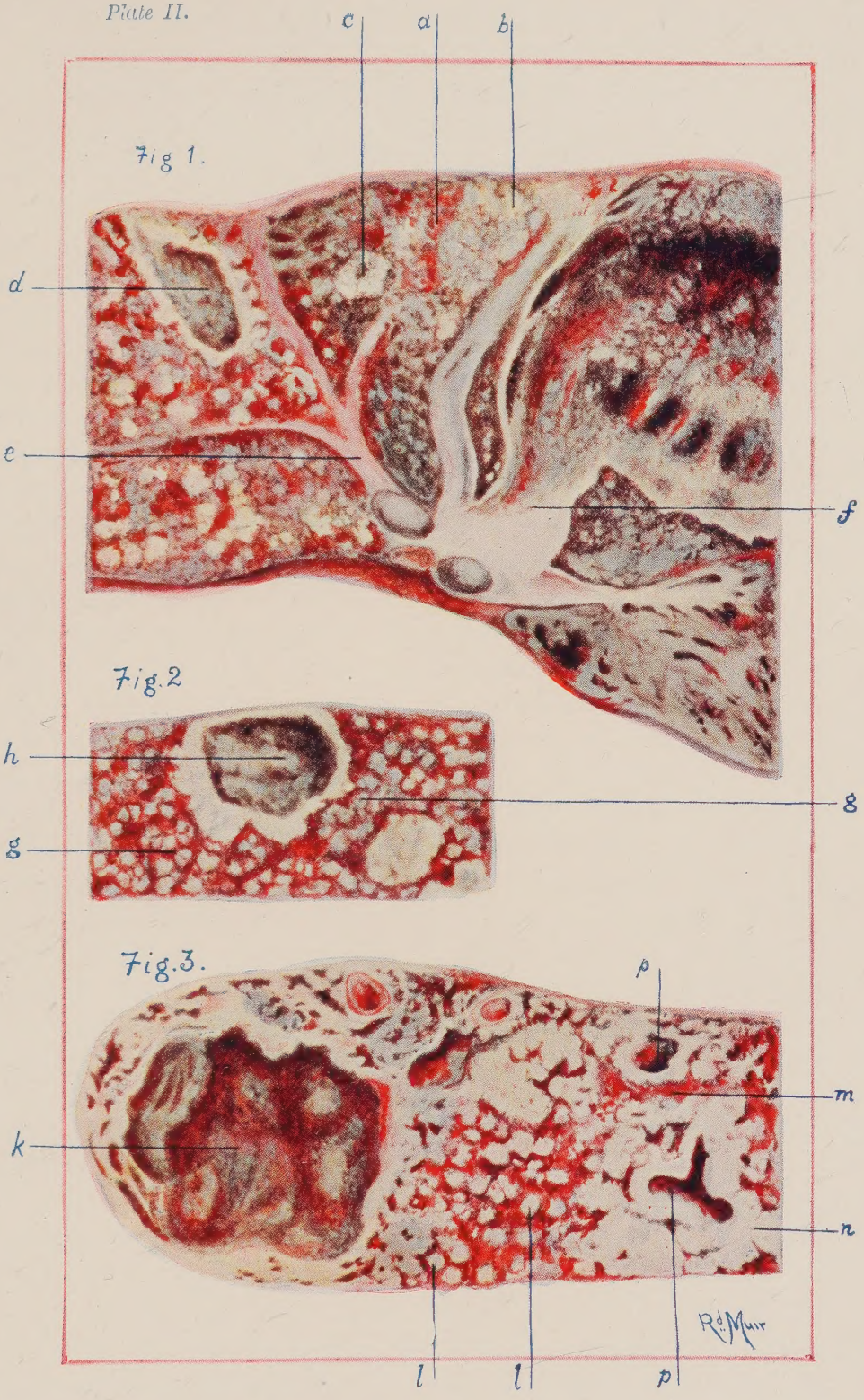
(*k*) Large cavity.

(*l*) Tubercles surrounded by pneumonic infiltration.

(*m*) Recent congestion and hepatisation.

(*n*) Caseous pneumonia.

(*p*) Little cavities in course of formation surrounded by caseous pneumonia.



SECTION OF LUNG SHOWING OLD CAVITIES AND TUBERCULAR GRANULATIONS.

(After the Plate in "La Phtisie Pulmonaire.")

essentially those in which, if taken early enough, a fair hope of recovery may be entertained from treatment on open-air principles. The tendency to sclerosis, however slight it may be, is, in itself, some indication that a battle is going on, that the patient is not succumbing out of hand to the inroads of the bacillus, and that, properly fortified by pure air and abundant food, he may be able to hold his own against, and eventually eradicate, the disease. It is in these cases also, when the stages of softening and cavity formation are reached, that *mixed infection* plays so important a part. The streptococcus and staphylococcus pyogenes aureus once having obtained a lodgment in the broken-down products of a softening tubercular focus, engender a septic condition, which is manifested by a rise in temperature. The pyrexia in phthisis is, in the opinion of Koch and many of his disciples, principally, if not entirely, due to the toxic products of these septic micrococci, and not to the toxins of the tubercle bacillus. This view is not universally accepted, and Kingston Fowler dissents from it. It must be borne in mind, however, in support of the very strong views of Koch, that lesions which are purely tubercular in character even when completely broken down, but to which no septic cocci have found entrance, produce little or no pyrexia. The various forms of so-called "cold abscess" with which tubercular disease is associated are a good instance of this.

That mixed infection is invariably present in all cases of slight temperature arising from tubercular lesions is improbable, but that the introduction of the streptococcus and staphylococcus pyogenes aureus to any lesion invariably raises the temperature is undoubted. So unmistakably is the temperature of phthisis associated with the septic micrococci in the opinion of certain German

physicians, that Pfeiffer, in his paper on Mixed Infection at the Berlin Congress (1899), recommended that, as phthisical patients with pyrexia were to a certain extent sources of danger to uncomplicated cases, it was advisable to separate patients in sanatoria with fever from those without fever.

The morbid anatomy presents appearances as varied as the clinical history. Lesions in all stages may be found—the nodular tubercle, diffuse infiltrated areas, caseous masses, alone or surrounded by fibrous areas, in which lime salts may be densely deposited; caseous nodules that have undergone calcification may subsequently disintegrate and even appear in the sputa of the patient. Pneumonic patches of varying size often occur, as well as cavities from the size of a hazel nut to the entire extent of a lobe, some with a fibroid capsule, others with ragged, broken-down edges. (Frontispiece and Plate 2.) The pleuræ are constantly involved by actual tubercle, by adhesions and thickenings, by perforation, leading to pneumothorax and pyopneumothorax. Bronchi and bronchial tubes have their lining of mucous membrane congested, swollen, and ulcerated, their actual substance invaded by tubercle, from which the disease not infrequently starts. (Fig. 4.)

The presence of compensatory emphysema in tubercular lesions of the lungs is generally found; the sites are the usual ones along the margins of the lungs, and also surrounding and associated with the tubercular deposits. In clinical investigation of a case of phthisis the possible discrepancies in the physical signs due to emphysema should not be overlooked. In the larynx, ulceration of the vocal cords, and even the epiglottis, is a common condition which may cause much suffering to the patient.

The distribution of the lesions in the lungs varies, but practically they almost invariably begin in one or

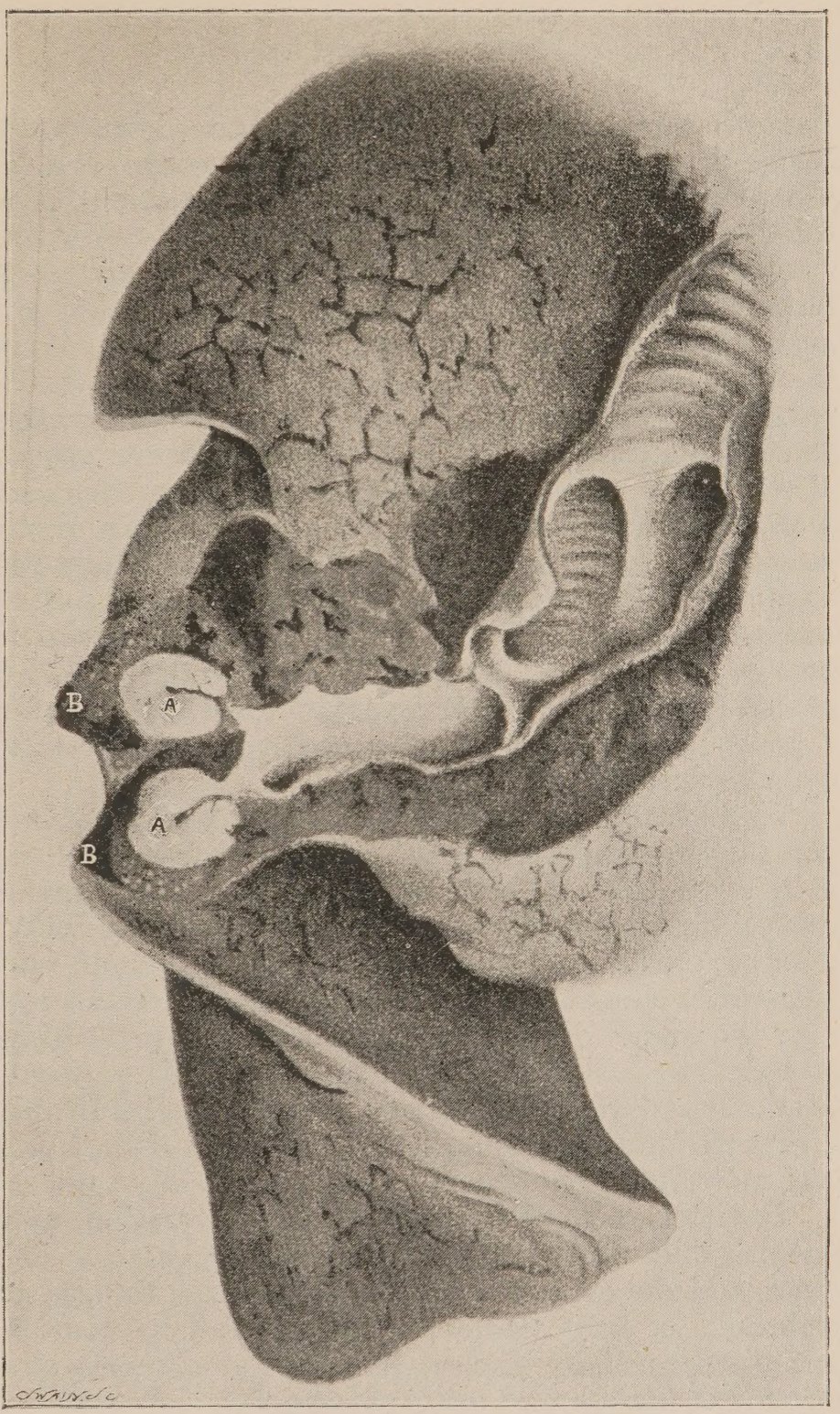


Fig. 4.—Incipient Tuberculous Endo-bronchial Inoculation. (A) Nodule laid open. (B) Atelectasis of lobule beyond (after Birch-Hirschfeld).

the other apex, and travel from there downwards. Kingston Fowler has traced a certain course which the disease usually follows. The initial lesion, as a rule, is from an inch to an inch and a half below the summit of the lung, and near the external and posterior borders, and may generally be detected by auscultation in the supra-spinous fossa before it is recognisable in front. Anteriorly, this focus corresponds to a spot just below the middle of the clavicle, and as it extends along, the anterior aspect of the upper lobe may be detected in a line about an inch and a half from the inner ends of the first three interspaces. By the time the disease is clinically recognisable in the upper lobe, the lower lobe, as a rule, has been invaded. The commonest spot for invasion here is about an inch to an inch and a half below the posterior extremity of the apex, and the best site for detecting it by auscultation a spot opposite the fifth dorsal spine.

From these observations it is evident how important the careful posterior auscultation of the apex is in early cases of phthisis. At the same time, the course followed is frequently a considerable modification of the above, and the one broad fact of real practical value is that the invasion is almost always near the apex. Percy Kidd estimates the proportion of apical to basic primary lesions in phthisis as 500 to 1. It is, however, quite common, where the disease is of any duration, to find arrested lesions of the apex and more recent ones in the base.

Cavities are all produced by ulceration and necrosis, but differ very much in character, size, contents, and the constitution of their walls. Bridges or trabeculæ of lung tissue are often found in cavities, and consist usually of partially obliterated vessels and strands of fibrous and elastic tissue to which more or less pulmonary tissue in various stages of dis-

integration is attached. As a rule, the process extends from a bronchus, but it may occur in any caseating mass.

The three fairly well-defined varieties are described by Osler as :—

(*a*) *The fresh Ulcerative.*—These are found in acute cases, and also in the parts freshly invaded in chronic cases. The walls are ragged, soft, and caseous, with no lining membrane. Such a cavity as this is often found in a lung the apex of which contains cavities with well-defined walls.

(*b*) *Cavities with well-defined Walls.*—These have a lining membrane, the surface of which produces pus. A series of these, generally intercommunicating, may occupy a part or whole of an upper lobe; in some cases, the process extends to excavation of the lung. These cavities contain pus similar to the nummular sputa of consumptives.

(*c*) *Quiescent cavities* are characterised by fibrous walls. The lining membrane is smooth, and often contains blood-vessels partially obliterated, and occasionally showing dilatations of an aneurismal nature. These aneurisms are sometimes of large proportions, and the danger from such a condition can hardly be overestimated, as the ulceration or rupture of such aneurisms is the usual cause of late and fatal hæmoptysis in phthisis. I saw a case quite recently in which an aneurism, from which a fatal hæmorrhage occurred, was found as big as a walnut. The larger cavities secrete a more or less liquid fluid for long periods, and may ultimately become dry.

Associated with phthisis—and, indeed, often directly dependent upon it—tuberculous lesions of every organ and tissue of the body may occur. Waxy or amyloid degeneration of the kidneys, liver, and spleen is not uncommon. A degree of fatty infiltration of the liver is usually present, but is not often recognised clinically.

The Establishment of the Disease.—The *onset* of the disease is often misleading and uncertain, and while we must avoid hasty diagnosis, the importance of recognising the disease early is obvious. The early history of a case may be indefinite. Tact and observation are often necessary to obtain a satisfactory account of the patient's previous illness. The modes of onset vary considerably :—

(*a*) A common history is that of insidious onset, marked by a period of ill-health following influenza or other febrile disease. Dyspepsia, anæmia, loss of weight, cough, with or without expectoration, and shortness of breath, may all be complained of.

(*b*) A "neglected cold," or bronchitis which tends to recur every year, may gradually lead to the establishment of phthisis and the true nature of the disease be overlooked if the sputum be not examined.

(*c*) A slight attack of hæmoptysis in an apparently healthy and robust individual may be the only cause of his seeking medical advice. Development of other clinical signs may follow rapidly or be considerably delayed.

(*d*) A pneumonia instead of resolving may become chronic, and being infected by the tubercle bacilli, phthisis results.

(*e*) Pleurisy, with or without effusion, may for long be considered the only affection, and only at a later date the essential nature and cause of the disease be recognised.

(*f*) Occasionally the patient complains primarily of affection of the larynx, characterised by partial loss and painfulness of voice. This condition, however, is more usually secondary to pulmonary phthisis.

SYMPTOMS.

Cough.—The most important symptom is cough;

though in rare instances absent, it appears usually to usher in the disease and persist during its whole course. The cough is at first usually dry and short, but later on, and occasionally from the commencement, is associated with glairy, muco-purulent sputum. Cough is most troublesome at night-time, and will often keep the unfortunate patient awake for hours, till he becomes careworn, thin, and exhausted. After exercise it may be also increased. Severe bouts of coughing, particularly in the later stages, often cause vomiting, the patient rapidly emaciating in consequence, while, when cavities have formed, the attacks become more paroxysmal, especially in the early morning after sleep.

Sputum.—Expectoration, though sometimes scanty or even absent, occurs early in the disease, and when associated with a persistent hacking cough should never be overlooked.

How often in out-patient practice the only complaint is "cough and spit." Small greenish-grey purulent masses, and a clear, at times frothy, sputum are characteristic early in the disease. As softening of the caseous lung tissue occurs, the expectoration becomes very profuse and nummular when cavities exist. These muco-purulent masses, when coughed up in the morning, should be chosen for microscopical examination. The best method for preparing cover glass specimens, with a description of the bacillus, is described elsewhere (p. 15).

As the presence of bacilli in the expectoration is pathognomonic of phthisis, the importance of carefully examining the sputa in every doubtful case is evident.

The bacilli are often difficult to find, and repeated cover glass preparations may be necessary before a positive opinion in any case can be given.

The presence of elastic tissue in the sputa is not

to-day of so much diagnostic importance as formerly. If derived from the bronchi, it may take a reticulated form, or be composed of several strands, or be very fragmentary; it may have a similar form when it has come from the elastic lamina of an artery; when the alveoli have disintegrated, the resulting elastic tissue may show the outline of the air cells and be much branched.

Blood, epithelial, and pus cells may be found in tubercular sputa, and also various forms of septic micrococci. The aspergillus fungus may sometimes be found in the sputa, derived from vomicæ of chronic cases.

Pain.—Pain in the chest is sometimes complained of. It is usually referred to the upper part of the chest, in the infra-clavicular or mammary regions, but, not infrequently, it is felt in one or other part of the lower thoracic zone.

Pain is due generally to the involvement of the pleuræ; and it may be sharp and piercing in character, or only be felt during coughing or deep respiration.

Dyspnœa is not so pronounced as one would expect from the nature of the disease. It is, however, usually present to some degree after exertion; and the number of respirations is increased as the tubercular process advances, and broncho-pneumonic patches are developed.

Hæmoptysis.—Hæmorrhage may occur without evidence of other complications. At one time it was the fashion to speak of such hæmorrhages as "precursory hæmorrhages," but to-day there is little doubt that, in the great majority of cases, the disease is in existence at the time of the hæmorrhage, although such disease may not be recognisable by any other clinical sign. Its occurrence can never be ignored. Hæmorrhage occurs in late stages, and, not infrequently, is the cause of a fatal termination.

Hæmoptysis differs both in character and origin, and it must not be forgotten that it does not invariably arise in the lungs, and that even when it does, it does not necessarily signify tuberculosis. The history of the case must be carefully gone into and the throat examined.

When the pulmonary origin is established, and the sputa are mixed with blood, the condition is generally that of congested mucous membrane, or lung tissue. Where the blood is unmixed, and comes up in some quantity, there is usually softening and erosion of vessels.

Profuse pulmonary hæmorrhage occurs when an aneurism in a cavity, or one of the larger branches of the pulmonary artery, is ulcerated into.

Fever.—The causation of pyrexia in pulmonary tuberculosis has been discussed (p. 39).

A frequent and regularly kept temperature record is important, as the temperature is of great clinical value.

Loss of strength and weight are closely related to elevated temperature in phthisis, and, conversely, the patient gains in bodily weight and strength, and feels better, during any prolonged period of apyrexia.

The temperature, which is usually intermittent, or remittent, should be taken every four hours, either in mouth or rectum. A continued fever of any duration is rare. In the more chronic cases, with the breaking down of pulmonary tissues and the formation of cavities, complicated as they usually are by the invasion of the septic micrococci, with a resulting mixed infection, the temperature almost invariably intermits and assumes the typical hectic character.

The temperature in the evening may run up to 103° or 105°, and in the morning be subnormal and fall to 95°. Sweating seems to be associated with the morning decline in the temperature.

Osler especially insists upon the fact that phthisis may, particularly in malarious districts, set in with apyrexia, intermittent in character, a daily chill being followed by fever and sweating, and closely simulate malaria; such cases run a rapid course. There may be extensive disease in chronic cases without fever.

The Pulse.—The pulse rate is increased in frequency when the disease is accompanied by an elevation of temperature.

A slow pulse is more common when the disease is associated with a low temperature, the number of pulsations ranging from 70 to 90 per minute. The association between temperature and pulse rate in phthisis is not, however, constant. The general vitality of the patient would seem to be an important factor.

Rapidity and low tension of the pulse rate occur in the later stages of the disease.

Sweating is a most common and troublesome symptom. It usually occurs at night, and during the day to a less extent, when the patient sleeps. Profuse sweating is usually associated with the later stages of the disease.

Emaciation progresses with the development of the disease, and is often dependent upon pyrexia, loss of appetite, diarrhœa, and sweating. During an arrest of the morbid processes the patient gains weight.

Pneumothorax is not an uncommon complication of phthisis, and occurs when a tubercular deposit ulcerates through the pleura into the pleural cavity. Pneumothorax more often occurs in the fibro-caseous and pneumonic form of phthisis than in the fibroid. According to Samuel West,* about 5 per cent. of phthisis cases die of pneumothorax. Where the pneumothorax is of at all an extensive character, the occurrence of pleural perforation and escape of air

* *Lancet*, vol. i., 1884, p. 791.

into the pleural cavity is accompanied by pain, general shock, and dyspnœa. On the other hand, pneumothorax of a more limited character occasionally supervenes without giving rise to marked symptoms, and is sometimes only discovered on the post-mortem table. The extent of a pneumothorax depends on pleural adhesions, and only occasionally is the whole or even greater portion of the pleural area involved in pneumothorax arising in phthisis. In extensive cases the heart is driven over to the sound side, there is loss of movement on the affected side, and the voice is reduced almost to a whisper. The escape of pus through the pleural opening into the pleural cavity may set up pyo-pneumothorax. The physical signs are referred to below.

Alimentary System.—Subjective symptoms of thirst, anorexia, nausea, vomiting, and dyspepsia may all be complained of. The tongue is often furred, and aphthous patches, particularly in late cases, may be troublesome. Dysphagia occurs when there is tuberculosis of larynx and pharynx. Though diarrhœa is usually a late feature, it may come on early. It is caused in the first place by catarrh, and later by ulceration of the intestine. In later stages it is often a manifestation of waxy or amyloid degeneration of the bowel, and is then accompanied by symptoms of a similar change in other organs, such as enlargement of the liver and spleen. Palpation of the lower abdomen may elicit pain when ulceration of the intestine is present, but hæmorrhage or perforation is very rare. As a concomitant of pulmonary tuberculosis, fistula in ano is not uncommon.

Hæmopoietic System.—A reduction of the red blood corpuscles, rarely below two million per cubic millimeter, and increase in the number of blood platelets and leucocytes are often to be noted. Enlargement of the spleen from waxy degeneration may be present.

Circulatory System.—The association of endocarditis with phthisis may occur, but is not common. A diffuse pulsation in the region of the præcordia from retraction of the left lung is often noticed. Over a consolidated apex the cardiac sounds may be intensified.

Adventitious murmurs accompanying the heart's systole are frequently heard; for these the pulmonary area is the most common seat, but they may at times be heard over the subclavian artery and the mitral and aortic areas.

The pulse in phthisis, though full, is usually soft, owing to a diminished arterial tension aud a relaxed condition of the capillaries.

Integumentary System.—A malar or hectic flush is common. Pigmentation of the skin (chloasma phthisicorum), very similar to the chloasma seen in cancer, and development of pityriasis versicolor, a skin disease characterised by brownish and branny patches of the skin, due to the "microsporon furfur," are often met with, especially in the later stages of the disease. The subject of sweating in phthisis has already been discussed. The occurrence of clubbing of the finger- and toe-tips in all forms of chronic lung disease is well recognised. Sudamina in children and swelling of the ankles from anasarca are not uncommon.

Genito-Urinary System.—Waxy or amyloid disease of the kidneys may be characterised by polyuria, the urine being clear and of low specific gravity, and containing much albumen. Tubercular pyelitis, or cystitis from pyuria and a degree of hæmaturia, with frequency of micturition, may occur. The presence of bacilli in centrifuged urine is sometimes detected.

Tubercular orchitis, the epididymis being primarily involved and enlarged and the cord thickened, may

be looked for. Menstruation may be delayed or scanty, and amenorrhœa is common.

Nervous System. — Tubercular nodules in the brain, especially in children, giving rise to localising symptoms and less commonly tubercular meningitis, are occasionally met with. Peripheral neuritis is very uncommon, but does occur. The peculiarly hopeful frame of mind (spes phthisica), the non-impairment of intellect, perception, and memory, and vividness of imagination even to the end, are proverbial features of the disease. The terminal stage of phthisis, though rarely, may be marked by acute mania.

Locomotory System.—Clubbing of the fingers and toes has already been alluded to. The rare clinical condition caused by chronic chest disease, to which the name hypertrophic pulmonary osteo-arthropathy has been given by Marie, consisting in an enlargement of the osteal and soft parts of the fingers and their joints, and also more rarely of the wrists, ankles, elbows, and knees, whereby these structures become bulky, ill-proportioned, clumsy, and impaired in movement, may sometimes be met with.

PHYSICAL SIGNS OF PHTHISIS.

To elicit these, inspection, palpation, percussion, and auscultation are employed, and although they are here described separately they may in practice be variously combined:—

(1) **Inspection.**—No type of chest is free from the possibility of tuberculosis, although certain types have come to be regarded as specially liable to affection. Thus the chest of the phthisical patient is often flattened antro-posteriorly, or it may be long and narrow with very wide intercostal spaces and projecting scapulæ.

Careful scrutiny of the apices, both from behind, in front, and above, during respiration may determine the presence of defective expansion of these parts, a most important early sign.

The supra-spinous and supra-clavicular regions may be much depressed if a cavity exist in the upper lobe of the lung, and the scapula and clavicle be markedly prominent. Expansion is then much diminished.

In chronic phthisis with much fibroid contraction the intercostal spaces are depressed, expansion during respiration almost absent, and the cardiac impulse displaced and diffused.

The modification in the appearances of the chest walls is so marked in advanced stages of phthisis that one sometimes questions whether the so-called "types" of chest said to be peculiarly favourable to phthisis are not effects rather than causes.

(2) **Palpation.**—Careful palpation of the apices, and comparison between other similar areas of the chest, in conjunction with inspection, may determine a diminution of expansion and so point to commencing disease, even though percussion is negative. To gauge the vocal fremitus the patient should utter, with a full, strong intonation, such words as "one, one, one," or "ninety-nine," and a careful comparison between the two sides of the chest be made. An increase of fremitus is caused by consolidation (tuberculous or otherwise) and by vomicæ when they freely communicate with a bronchus; but a pleuritic thickening or effusion may diminish or even obliterate it.

The fremitus, it should be remembered, is normally greater on the right side.

(3) **Percussion.**—In the early stages percussion often fails to give positive evidence, but if it be performed lightly over the clavicles, especially after a

full inspiration, a slight degree of dulness may be detected.

The areas where percussion usually obtains evidence of disease are the supra-clavicular, infra-clavicular, supra-spinous, and the inter-scapular. The supra-spinous and inter-scapular are frequently the first areas in which dulness may be detected. A slight degree of hyper-resonance is often an early sign. When consolidation is fairly well established, or when in very chronic phthisis there is a degree of cirrhosis of the lung with thickening of the pleuræ, the note is dull, and there is a sense of resistance to the percussing finger.

Distinct dulness of the apex, either in front or back, may be attended with a hyper-resonance in the corresponding posterior or anterior region of the same side. (Wilson Fox.) In pneumothorax the note is hyper-resonant. Hyper-resonance of a tympanic character is heard over a thin-walled cavity near the surface, and during inspiration, if the patient's mouth be open, the cracked pot sound may be elicited. The recognition of deep-seated cavities is by no means easy.

(4) **Auscultation.**—(*a*) *Character of Respiration.*—Faintly heard breath sounds, with prolonged expiration, are often characteristic in the early stage, though harsh respiratory sounds, which may be jerky or cogwheel in character on deep breathing, are also common. With the further advance of the disease the breathing becomes harsh and puerile, with markedly prolonged expiration, and later the character of the respiration becomes bronchial. The highly pitched tubular breathing, like that produced in pneumonia, is rarely heard except where there are large areas of consolidation. When cavities exist, the character of the sounds may be simply bronchial, but more commonly they are loud and

cavernous, or even amphoric. In pneumothorax the breath sounds are feeble or not heard at all. By coin percussion a ringing sound is elicited.

(*b*) *Crepitations, or Rhonchi—râles.*—Fine dry clicks or crepitations early in the disease are most suggestive; they may be very few and occur only during inspiration or coughing, later they may be more abundant and occur both during expiration and inspiration. The patient while being examined should every now and then be directed to give a slight cough; this dislodges plugs of mucus from the air tubes, and develops râles which would otherwise have remained in abeyance; a friction rub, pleuritic in origin, may often be heard. When the lung tissue commences to soften and disintegrate, the sounds become "moist" and bubbling, and sometimes sibilant wheezing rhonchi are heard. When cavities exist, these crepitations have a louder and more metallic sound, and are often very numerous. Owing to the temporary occlusion of a bronchus, the breath sounds over a cavity may temporarily become indistinct or inaudible.

(*c*) *Vocal Resonance.*—The condition of the vocal resonance is very important. It is increased in all stages of the disease, unless obscured by pleuritic thickening, pleural effusion, or emphysema; the resonance in consolidation becomes loud, and the spoken words are heard distinctly (bronchophony); while when the lung tissue has disintegrated and cavities are present, whispered words also become clearly audible (pectoriloquy).

The physical signs of cavities, and indeed any stage of phthisis, may present many anomalous features and are often deceptive, extensive disease existing without corresponding external evidence; and the vocal sound heard in consolidation about a bronchus may simulate very closely, and often be indistinguishable from, those heard over a vomica.

Diagnosis.—Little need be added under this heading. It is essential, however, that no one symptom or physical sign should bias our further examination, and in the sputum of every case, as a routine practice, the tubercle bacillus should be sought for. The presence of elastic tissue is of subordinate importance.

The staining of cover glass preparations may be repeated many times, and considerable trouble be expended, and still the sputum may give a negative result; but as the recognition of the bacillus is such an unmistakable indication of the true nature of the disease, the test must be applied with patience in all doubtful cases.

Prognosis is practically dealt with in Chapter VII. on Treatment.

(B) FIBROID PHTHISIS (FIBROID TUBERCULOSIS OF THE LUNGS).

This is often a later stage of the fibro-caseous form of pulmonary tuberculosis. It may also be started by silicosis, from the inhalation of stone dust, anthracosis, from the inhalation of coal dust, or from a condition of cirrhosis set up by the inhalation of metallic dust from certain factories. The disease is thus not uncommonly met with in stonemasons, coal-miners, knife-grinders, and others exposed to the inhalation of irritable dust. When fibroid phthisis starts in this way, however, it is, of course, necessary that the tubercle bacillus should be established upon the already existing fibroid condition before pulmonary tuberculosis actually occurs. There is some difference of opinion and practice in the use of the term "fibroid phthisis," some writers, such as Clark Hadley and Chaplin, applying it to the fibroid condition set up by irritant dust. The

term is confined by the writer of this work to a tuberculous condition. Some acute forms of phthisis which undergo partial or complete arrest of the disease develop a cirrhotic or fibroid change. Fibroid disease may follow an acute lobar pneumonia in which resolution has been defective, with a resulting interstitial change.

Symptoms.—In patients who have had recurrent attacks of bronchitis, and who complain of having "suffered from their chest" for a long period of time, fibroid phthisis may present very uncertain signs.

As compensatory emphysema is such a marked pathological feature, dyspnœa, or "shortness of breath," is a common symptom. Cough, often paroxysmal, with purulent expectoration, and bronchitic and asthmatic attacks occurs. Dilatation of the right ventricle of the heart and its attendant symptoms are present, and there is usually a degree of brochiectasis. This disease is very chronic, and may run on for even twenty years, the patient as often as not succumbing to disease other than pulmonary.

Hæmoptysis, by no means an infrequent symptom, is usually recovered from, while an apyrexial course is a common feature of the disease.

Bacilli may at times only be found in the sputa with difficulty, and for long periods they may be entirely absent.

Physical Signs.—Retraction of the interspaces and flattening and immobility of the affected side are noted on inspection; the heart is often displaced and uncovered from contraction of the lungs, and the area of pulsation much increased. Percussion may elicit areas of great dulness. Often hyper-resonance occurs as the result of emphysema.

The unaffected lung usually is emphysematous. The condition of the vocal fremitus and resonance

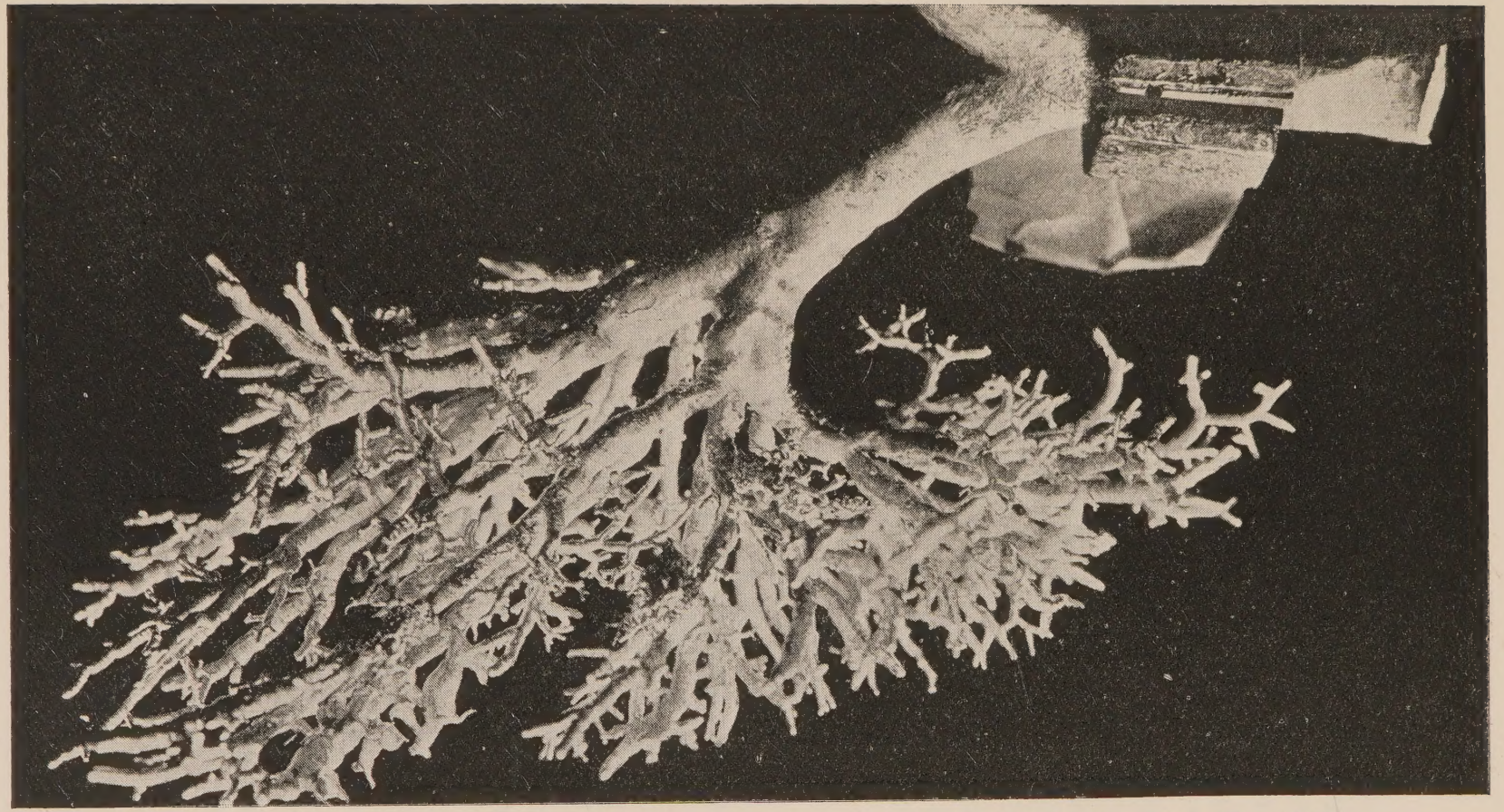


Fig. 5.—Cast of Bronchial Tree in Fusible Metal. Front view of left lung (after Birch-Hirschfeld).

depends on the state of the pleura and the lungs. All the auscultatory phenomena vary considerably; weak breath sounds, with prolonged expiration, are common, and point to the presence of emphysema, while not infrequently cavernous or bronchial breathing may be heard at the apices or bases, according to the varying condition of the underlying lung.

Prognosis. — Death may occur from gradual failure of the right chamber of the heart with dropsy, and more rarely from hæmoptysis, or from general inanition from waxy degeneration of the organs. On the other hand, under favourable conditions, arrest of the disease and even cure may be obtained.

TUBERCULOSIS OF THE SEROUS MEMBRANES.

1.—**General Tuberculosis of the serous membranes** sometimes occurs. It may assume an acute or a chronic form.

(*a*) The acute form is caused by previously existing visceral disease, which may affect the peritoneum, the pleura, and also even the pericardium.

(*b*) There is also a chronic form, with characteristic caseation and disintegration, with matting and adhesion of the membranes and the formation of tubercular pus. This condition may terminate fatally, or a fibroid condition may supervene and a period of arrest be established. In these cases the membranes are much thickened and fibrous, the serous or pus effusion is scanty or absent, and the tubercular nodules become hard and nodular and show little tendency to caseation. General tuberculosis of serous membranes is a much more common form of tuberculosis among the negroid races than among Europeans. In the Kimberley Hospital I have seen many cases both of the acute and chronic forms.

Peritoneal tuberculosis occurs at any age, though it is most common in adults under forty, and children; it is rare over fifty: most cases are said to appear in females.

In my own experience the disease is commoner in the male Kaffir than the female.

Peritoneal tuberculosis may be acute or chronic.

Acute.—Not infrequently the peritoneum is affected in chronic pulmonary tuberculosis. The nodules are grey granular bodies not unlike boiled sago grains, and line the peritoneum. When there is an acute miliary tuberculosis affecting the peritoneum, exudation may occur—it is generally sero-fibrinous, and may also be hæmorrhagic. This condition may advance and take on a chronic course.

Chronic.—Chronic peritoneal tuberculosis is often simply a later stage of one of the acuter varieties. It frequently commences in women from disease of the Fallopian tubes, while in chronic phthisis the infection spreads to the intestines and thence to the peritoneum. Osler states that it is commoner in the negro than in the white race in America. It is a common form of tuberculosis among the negroid races in Africa. A large proportion of the native deaths from tuberculosis in the Kimberley Hospital showed extensive affection of the peritoneum.

The chronic forms at times are characterised by large growths, which caseate and break down with a sero-purulent exudation. Adhesions of the intestines to each other and other organs often are so arranged as to form sacculations, in which the pus collects.

In other cases there is little or no exudation; the nodules, which are hard and discoloured, show little tendency to caseation, while the intestines are firmly matted together by dense fibrous adhesions.

When collections of pus occur, perforation of the intestine may take place.

Symptoms.—From the many conditions which may arise in peritoneal tuberculosis, it follows that the symptoms are somewhat varied. It is sometimes overlooked and not recognised during life; it may at other times set in abruptly with fever. Chronic cases are not infrequently met with accidentally during abdominal section for other conditions.

Tympanitis from loss of muscular tone of the intestines, and fever, are marked in the acuter cases, while in the chronic forms, though the temperature may rise and fall, it is more common to have a subnormal temperature.

Ascites, though rarely abundant, is generally present; as in cancer, it may be hæmorrhagic.

A diagnosis of Addison's disease has sometimes been made, from the occasional pigmentation of the skin which at times accompanies the very chronic cases.

The more chronic cases may closely simulate, and are often mistaken for, typhoid fever.

In the chronic form, from matting together and thickening of parts of the intestines and omentum, or sacculated exudations, the physical signs may almost exactly resemble tumours, either solid or fluid.

The difficulty in diagnosis of these peritoneal tumours is often considerable; a sacculated accumulation of tubercular exudation is often mistaken for a cystic ovarian tumour, and, indeed, many of the operations performed for the relief of the latter condition have proved to be tubercular in nature. In arriving at a conclusion, the tubercular condition may not be suspected from the general condition of the patient, but a careful examination for phthisis or disease of the Fallopian tubes should be made; the withdrawal of fluid from the tumour sometimes aids diagnosis.

TUBERCULAR PLEURISY.

Modes of Infection.—Tubercular pleurisy, as commonly met with, is the result of a direct spread of the disease from the subjacent lung. It has been shown that infection of the pleuræ may occur by an extension from the peritoneum through the diaphragmatic lymphatics; while the glands at the root of the lung and the cervical glands are sometimes the seat of the origin.

Forms of Tubercular Pleurisy.—Acute and chronic types are recognised clinically.

(*a*) *Acute.*—Under this heading come certain cases which, resembling an inflammatory pleurisy from chill, run a rapid course, with abundant sero-fibrinous exudation; no suspicion of their true nature may be entertained, and an examination for the tubercle bacilli in the fluid withdrawn from the chest will probably be negative.

Not infrequently these cases appear partially to recover, until a recurrence of the pleuritic disease, with abundant sero-fibrinous or purulent exudation, occurs.

(*b*) *Chronic.*—Several varieties of the chronic form have been described, but it is difficult to differentiate them in practice. Insidious in onset, and resembling an intractable form of simple pleurisy with effusion, and often gradually assuming an empyematous type, their true nature is too frequently only recognised in the post-mortem room.

In the majority of cases tubercular pleurisy is simply a secondary development of pulmonary tuberculosis, and where the pulmonary tuberculosis is clearly marked, the recognition of the true character of the pleurisy is not difficult. It is in those cases where there has been little or no evidence of pulmonary tuberculosis that the diagnosis becomes difficult.

Tuberculosis of the Pericardium.—The pericardium, like any other tissue, may be infected with miliary tubercle as part of a general infection. But cases primary or secondary in character, although rare, do occur. Osler records seventeen which came under his own observation. Effusion may or may not be present, and the symptoms are those of ordinary pericarditis.

Tuberculosis of the Brain and Spinal Cord.—Meningitis, associated with acute miliary tuberculosis and hydrocephalus, has already been described; and the more chronic forms only remain for consideration. Of these, the tuberculous solitary tumours, met with chiefly in children, are the most important; but a more diffuse tuberculous affection of the membranes of the brain, or meningo-encephalitis, is also occasionally seen, with thickening and adhesion of the pia mater, and the growth upon the arteries of small nodules, leading to hemiplegias and aphasia.

The tuberculous tumour, involving the brain, is most often found in children under fifteen, and is generally a local manifestation of the disease existing in other organs, such as the lymphatic glands, the bones, and lungs. Though the name "solitary tubercle" has been given, it is often found that chronic tubercle of the brain exists in the form of multiple growths, which vary considerably, but are usually the size of a marble embedded within the cerebral substance. Firm, yellowish, and caseous in appearance on section, each mass is surrounded by a zone of tissue, less firm in consistence and somewhat translucent, and an attachment to the pia mater can generally be made out. The central part of the nodule may calcify, and these are the cases which have become arrested; while, at times, softening and further spread of the disease, with the incidence of meningitis, may also occur.

The symptoms, general and localising, which these

growths cause, are those usually associated with other cerebral tumours; the age of the patient and the condition of his lungs are, of course, important in diagnosis. The cerebellum is most commonly the seat of the tuberculous tumour; the cerebrum comes next in frequency, while in the pons varolii and other parts they are not often seen.

The spinal cord is rarely affected by tuberculosis, but when it is, the symptoms resemble those of meningitis or tumour.

TUBERCULOSIS OF THE ALIMENTARY SYSTEM.

The lips are very rarely affected, but a few cases of ulcer, extremely tender and painful, have been described by some writers.

The Tongue.—This is also an uncommon seat of the disease, and it derives its interest from the fact that it may be confounded with cancer or syphilis. The tuberculous ulcer, situated usually at the tip of the tongue, is irregular and shaggy, and may show a caseous base. It is tender and painful, and disease in other organs is found to co-exist. In syphilis the sore is usually on the dorsum, and the history points to its having arisen from the breaking down of a gummatous nodule.

The epitheliomatous ulcer, found generally at the edge of the tongue, has an indurated hard base.

The palate, tonsils, and œsophagus are occasionally involved, but tubercular pharyngitis, due to an extension of the disease from the larynx in chronic phthisis, is not very uncommon, and may cause severe and protracted dysphagia.

The Stomach.—Disease confined to this organ is unknown, and secondary ulceration is rare. Tubercular disease of mesenteric glands may involve and actually cause perforation of its walls.

The Intestines—(*a*) May be primarily affected; seldom in adults, but more commonly in children, in whom tuberculous affection of intestine co-exists usually with a tuberculous affection of the mesenteric glands or peritoneum. Sims Woodhead has shown the frequency of infection through the bowel in children. From the symptoms of the condition, chronic catarrh, with sometimes bloody stools, an error in diagnosis may be made. When the disease involves the cæcum recurrent appendicitis may be closely simulated, but at a later date, when the lungs become involved, its nature is revealed. Perforation with fatal peritonitis or hæmorrhage is rare.

(*b*) In chronic phthisis secondary implication of the bowel is common. The parts generally affected are the ileum and the large intestine. Deposit, with subsequent ulceration, in the Peyerian patches and solitary glands occurs, and a large area of bowel may be implicated at the same time; the ulcers, unlike those of typhoid fever, are irregular, with infiltrated and caseous bases extending as far as, and often involving, the muscular coat, and lie with their long axes at right angles to the long axis of the gut, and often partially surround it. The peritoneal coat of the intestine, which forms part of the base of each ulcer, is found to contain a number of small tubercular nodules, and not infrequently the mesenteric glands, and indeed the whole peritoneum, in the latter case from perforation, are affected. Intestinal tubercular ulceration may, as has been shown, in a few instances arise from disease of the Fallopian tubes in women, or from the glands or peritoneum in children. Perforation of the bowel may follow chronic tubercular peritonitis.

Symptoms.—The symptom chiefly associated with tubercular enteritis is diarrhœa, and this has already

been considered under the complications of the pulmonary disease.

In very chronic cases from cicatrisation of the somewhat annular ulcers and adhesions of the contracting peritoneum, a degree of stenosis, at times multiple, of the gut, with symptoms of constipation, distension of the abdomen, and visible peristalsis, and other signs of slow chronic obstruction, sometimes occurs.

Fistula in ano, resulting from tuberculosis of the rectum, is not an uncommon complication of phthisis; any operation undertaken should be for the complete excision of this tubercular focus.

The Liver.—The chief interest of tuberculosis of the liver is anatomical, as the condition gives rise to few or no symptoms; the organ is always involved in general miliary tuberculosis, the small nodules being uniformly scattered throughout the hepatic substance.

Tubercular caseating masses, sometimes of considerable size, with perihepatitis, are occasionally met with in chronic tubercular peritonitis; several varieties of tubercular cirrhosis have been described, but whenever the organ is affected by tuberculosis of a sub-acute or chronic character, or from chronic tubercular peritonitis, Glisson's capsule is involved, and an increase in the connective tissue of the organ takes place, which is commensurate with the chronicity of the disease. In some cases the cirrhotic change is so great as to cause considerable deforming of the liver; associated with this latter condition, firm, partially calcareous nodules may be found.

Tubercular cirrhosis of the liver is rarely so pronounced as to cause symptoms, but when it does these are ascites and the other symptoms of ordinary cirrhosis. Tuberculosis may manifest itself in the production throughout the organ of tubercles in

the smaller bile ducts ; these tubercles generally enlarge, caseate, and, breaking down, form multitudes of bile-stained abscesses within the liver.

Tuberculosis of mammary gland is uncommon, and most cases occur in middle-aged women ; it is occasionally found in the male. It may take the form of an ordinary cold or tubercular abscess, but it is generally seen when fistulæ exist, which are quite characteristic ; the axillary glands are usually affected, and when the disease is close to the nipple this structure is retracted.

TUBERCULOSIS OF THE GENITO-URINARY SYSTEM.

The Kidneys and Ureters.—A primary affection of the kidneys is said by some writers not to be very rare, but it is difficult to believe that some other form of tuberculosis does not exist in these cases to which the kidney affection is secondary. Miliary tubercles are usually found through the kidneys in general tuberculosis, and in chronic phthisis the kidneys are also not infrequently involved by several small nodules. The process of the disease in the kidney differs in no material respect from similar disease elsewhere ; a small tubercular deposit enlarges, caseates, and disintegrates, and cavities lined by cheesy and sometimes calcified matter may form, leading to a condition of tuberculous pyo-nephrosis, and the capsule is thickened and adherent. The upper part of the ureter and the pelvis of the kidney are usually involved. In some cases the disease may commence with a pyelitis. Disease of the bladder, vesiculæ seminales, prostate and testes, may co-exist. A spread of the condition may take place either from the kidney downwards or from the bladder and vesiculæ seminales upwards. One kidney only may be involved, yet both

organs are enlarged, and men in the middle period of life suffer more than women.

Symptoms.—For a long time these may be unimportant and attract no attention—later, however, those of pyelitis develop.

Frequency of micturition from the irritation caused by the purulent condition of the urine, and, later, the symptoms of cystitis, when the bladder is actually involved, arise. The urine is very thick, and contains particles of pus; notwithstanding, this is compatible with very moderate health. Later, when the process is advancing, and especially if both organs are involved, the temperature rises in the evening and may assume a hectic type; at the same time the patient loses weight, and may rapidly emaciate. Tuberculosis of other parts is generally co-existent. The presence of a renal tumour is seldom palpable, though there is marked tenderness either from the front or posteriorly. Pyelitis and pyo-nephrosis, originating from calculi, on the other hand, often cause palpable tumours, and also not infrequently hydronephrosis with its special symptoms. The urine contains albumen, pus, epithelium, and sometimes caseous particles and tube casts. Blood is more frequently present from pyelitis arising from calculous disease, while in all cases the urine should be carefully examined for the tubercle bacilli, which may readily be detected if a good specimen be thoroughly centrifuged.

The cystoscope may be used to ascertain from which ureter the tuberculous urine is coming, and catheterisation of the ureters, as introduced by Kelly for this purpose, is sometimes recommended.

The bladder is seldom primarily affected, and is usually involved from a spread downwards of the disease from the kidney and its pelvis, sometimes from the vesiculæ seminales or testes; the trigone and

the neighbourhood of the opening of the ureters is the part where the disease is chiefly met with.

A condition of chronic cystitis also occurs with tubercular deposits and patches of superficial ulceration with irregular margins and bases. The symptoms are those of protracted cystitis, with signs of tuberculosis elsewhere and loss of weight, and recognition of bacilli in the urine. Sometimes the symptoms may closely simulate those of stone. The cystoscope may be useful in this condition.

The testis is generally implicated, and associated with disease elsewhere; it is often met with in young children, when it is almost invariably part of a general infection. The epididymis is first affected, and becomes enlarged from deposits; these caseate and liquefy, and the testis becomes painful; the spermatic cord becomes thickened and the skin adherent; the body of the testis then becomes involved, and the tuberculous ulcers or abscesses erupt and leave typical tuberculous fistulæ and suppurating tracts. The vesiculæ seminales per rectum may be felt to be irregularly enlarged, and the prostate also if it be likewise affected.

In the diagnosis of the disease, a careful history—general, as well as of the local condition—is required, as it is necessary chiefly to diagnose it from syphilis. A syphilitic gumma commences in the body of the organ, the testis is enlarged and nodular, and the epididymis is only ultimately involved and enlarged, and the testicular sensation is abolished. While tubercle of the testicle may heal completely, it is more common for the disease to become general.

Uterus.—Tuberculosis of this organ is very rare; the few cases met with have generally been associated with phthisis. The endometrium is the part affected, but sometimes nodules have been found in the muscular coat.

Fallopian Tubes.—In girls and young women primary bilateral disease of the tubes is not very uncommon. The walls are infiltrated, thickened, and distended with tuberculous pus and caseating matter; the tubes are spirally twisted and adherent to the ovaries and fimbriæ. The association between this condition and peritonitis has been referred to.

JOINTS, BONES, AND MUSCLES.

Joints, bones, and muscles are all liable to be affected by tuberculosis, although muscles are only very rarely so. Joints and bones, on the other hand, are frequently the sites of disease. These cases are usually chronic in character, and as they come almost entirely under the hands of the surgeon, they will be dealt with but briefly in these pages. The factors which determine the onset of primary tuberculous disease—if, indeed, it ever be truly primary—in joints and bones form, however, a question of such deep interest to the student of tuberculosis that some consideration of the pathology of these conditions is necessary. In a joint the tubercular process usually begins in the synovial membrane, the bones entering into the structure of the joint are next most commonly affected, while ligaments and cartilage are only rarely the seat of primary disease. The incidence of this comparative liability is thus seen to be associated with the cellular activity of the tissues, those tissues being most susceptible which exhibit active cell life, and *vice versâ*.

The usually accepted explanation with regard to the onset of tubercular disease in synovial membrane or bone is that the tubercle bacilli or their spores are present in the tissues of the body, and that some injury, such as a strain or severe exposure to cold or wet, so lowers the vitality of the affected

synovial or bony area as to determine the establishment of a bacillary colony or tubercular focus at that spot. The inflammatory process which supervenes in a joint is characterised by the production of a flimsy gelatinous material of low vitality. The products of this process are neither sound enough to form substantial connective tissue,* nor innocent enough to be re-absorbed, nor "evil enough to break down into pus; and the compromise is the feeble, unstable, ill-formed, uncertain substance which is so marked a feature in the diseased joint."

Degeneration in a joint may go on to caseation, which, to all intents and purposes, is a necrosis; suppuration may then supervene. Repair after the slow healing process of tuberculosis of joints or bones is apt to be insecure, as it is in the lungs and elsewhere. The suppuration may be confined to the joint or invade surrounding tissues and form a periarticular cold abscess. Chronic tubercular synovitis most commonly occurs in the young, and begins with slight pain, stiffness, and weakness. The swelling is pale in colour and doughy in consistency. The painful starting at night is symptomatic, and usually points to erosion of cartilage and exposure of bone. If unchecked, disorganisation of the joint with the formation of sinuses and fistulæ occurs, and with them a rise in the general temperature from mixed organismal infection. Spontaneous arrest of the tuberculous process at any stage of the disease is usually followed by some impairment of the joint —either a stiffness or weakness, or varying degrees of fibrous, and at times osseous, anchylosis.

TUBERCULAR DISEASE OF BONE.

The cancellous tissue of the ends of long bones

* "System of Surgery." Treves.

—the vertebræ, ribs, sternum, the bones of the carpus and tarsus, and the phalanges—are all prone to local disease, generally dependent upon some primary focus elsewhere.

The deposit of nodules of tubercular granulative tissue results in a rarefying ostitis or caries, whereby the Haversian canals become enlarged, the trabeculæ thinned and eroded by the cellular exudation and osteoclasts, the whole bony structure eventually becoming destroyed and replaced by the tubercular tissue, which caseates in the centre and later breaks down with abscess formation. The collection of pus may remain within the bone, but more usually from a spread of the disease it opens under the periosteum or externally, or it may form burrowing abscesses among the muscles. The granulation tissue may erode the articular cartilage, and so invade joint cavity. Other changes than these, depending on the acuteness of the disease, may follow the tubercular deposit. Thus in the condition known as dry caries, or "caries sicca," a portion of the bone becomes partially absorbed and calcified, while the surrounding granulation tissue scleroses, the whole process being unaccompanied by the production of pus; and in "caries necrotica" the central portion of the inflamed bone, from the cutting off of its blood supply, may die *en masse*, and, becoming separated from the surrounding bone, form a sequestrum.

In all cases a surrounding zone of inflammation accompanies the process, and the periosteum becomes thickened. Should the disease undergo partial and temporary arrest, the granulation tissue occupying the position of the destroyed bone organises and produces sclerosis; indeed, bony sclerosis here and there is an almost constant accompaniment of the disease. In youth, when the epiphysial junction of a long bone is involved, premature ossification often

occurs, with ultimate shortening of the limb. In rare instances, on the other hand, from delayed ossification active growth is promoted with consequent elongation.

Symptoms and Diagnosis.—Tubercular diseases of bone are characterised by chronicity, insidiousness of onset, and slow recovery. Pain of a deep-seated and "boring" nature, worse at night, is often complained of. It is much aggravated by exercise, and causes lameness. There may be a slight œdema, but seldom any redness unless the periosteum is involved, and in such cases only when the bone is superficial. Tenderness on firm pressure is a most important sign, as it enables us to locate the disease with some accuracy. Enlargement of the bone is only a late indication. Eventually, as the condition comes near the surface, there is redness; heat, œdema and fluctuation may be elicited. Or, on the other hand, there may be a fluctuation only, without the signs of inflammation, which points to the presence of a "cold" or tubercular abscess.

Tubercular periostitis, a primary affection of the periosteum, is very rare, but tubercular osteomyelitis is usually accompanied by periostitis.

Tubercular Abscess. — The so-called "cold abscess" (from the absence of inflammatory reaction) is tubercular in nature, and in nearly every instance has its origin in tubercular disease of a neighbouring gland, or joint, or bone. Thus, a gland having caseated, softened, and erupted, invades the adjacent subcutaneous cellular tissue, which, succumbing to the tubercular process, in time offers material for the formation of fresh tubercular pus. In this way a tumour is formed, at first appearing as a hard nodule consisting of tubercles, with surrounding inflammatory products. As the tumour enlarges the central tubercles caseate, and pus is formed, which

is enclosed by a distinct wall in which numerous small tubercles are embedded.

A tubercular abscess has a great tendency to burrow in the tissues, especially in the long axis of the body, following that course where there is least resistance, which is generally between muscular and fascial strata.

In this way the pus may spread a great distance from its original seat; and from the direction of the ligamentous, muscular, and fascial planes, the position of the psoas, lumbar, or femoral abscess met with in Pott's disease of the spine, is determined.

Ultimately the abscess, from destruction of the intervening tissue, reaches the skin, which becomes thin and inflamed; it finally ulcerates and gives way, with resulting evacuation of the contained pus.

Symptoms.—A fluctuating swelling without evidence of inflammation, and the presence of the cause of the abscess, such as disease of the spine, are the chief signs. The constitutional symptoms are notoriously slight before a tubercular abscess is opened, but when this occurs, unless scrupulous asepsis is maintained, mixed infection sets in with its attendant evils of a chronic suppuration, hectic temperature, and waxy or lardaceous disease of the viscera.

In some cases, when a large abscess has been opened, and aseptic precautions have been unsuccessful, the immediate result has been a toxæmia, with highly-elevated temperature, collapse, and rapid death.

Tubercular Teno-Synovitis: Compound Ganglion.—Compound ganglion is rare, but occurs most often in the palm of the hand, and is then called "compound palmar ganglion"; it is only recently that its

precise character has been ascertained, it being of the nature of a tubercular teno-synovitis.

Tubercular teno-synovitis affects most commonly the tendon sheaths of the wrist, chiefly on the palmar aspect; it is, however, also found about the ankle. Women are more often affected than men, especially those delicate individuals having manifestations of the disease elsewhere.

The tendon sheath is lined by an irregular, rough, sometimes smooth, membrane, which is not continuous, and from which villous projections and masses of rounded and oval bodies, the so-called melon-seed bodies, hang. Tubercular nodules with bacilli can be demonstrated in the outer portions of the membrane. The contents of the sheath consist either of a thin, clear, transparent fluid or a thick, gelatinous, and sometimes chocolate-coloured fluid, in which are numerous melon-seed bodies, which are smooth, polished, and whitish in colour; they vary much in size up to a quarter to even half an inch; on section they differ considerably in structure, some being quite homogeneous, others showing a reticulated or granular appearance. Miliary tubercles and bacilli are occasionally found in them.

A form of teno-synovitis, to which the name "Fungating tubercular teno-synovitis" is sometimes applied, is also described; it may commence as a primary affection in the synovial membrane covering a tendon and that lining its sheath, or arise from disease in the neighbouring bone, joint, or other tissue. The tendons usually involved are the same as those in the ordinary form of tubercular teno-synovitis, viz. those of the wrist, hand, ankle, and foot. The pathology of this condition resembles closely tubercular disease affecting the synovial membrane of a joint; the membrane shows a typically tuberculous structure, with numerous tubercles and

tubercular granulation tissue. The tendon eventually becoming implicated and eroded, is rendered functionless. The pulpy granulation tissue occupying the cavity of the tendon sheath sometimes erupts through the latter and forms a semi-fluctuating, boggy tumour under the skin.

Symptoms.—As in other tuberculous affections,

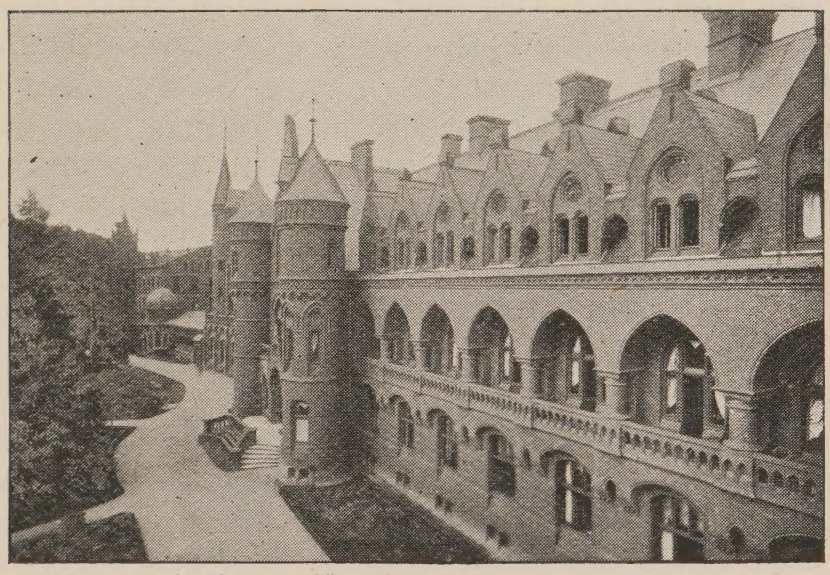


Photo: E. de Plangue, Görbersdorf.

Fig. 6.—Brehmer's Sanatorium, Görbersdorf.

the onset of tubercular teno-synovitis is very insidious and gradual, and it is often ascribed to some strain or injury. The disease being most commonly met with about the wrist and palm, and then known as a "compound palmar ganglion," it will suffice to describe the symptoms of this affection. A "compound palmar ganglion" forms a tense elastic swelling in front of the wrist and palm, constricted at its centre by the anterior annular ligament. The swelling occasionally extends along the flexor tendons of the thumb and little finger, and, in rare

instances, along those of the remaining digits; the movements of the hand and fingers are consequently impaired. Fluctuation can be elicited, and frequently the presence of melon-seed bodies can be determined, from the curious grating movements which occur as the bodies slip about from underneath the examining finger. If untreated, the contents may erupt, with a resulting fistulous opening, with all the evils of a mixed infection. The diagnosis of the above condition is readily made, though a fatty tumour of the palm or a chronic abscess may, in some instances, resemble it; puncturing of the swelling may occasionally be necessary to distinguish the compound tubercular ganglion from the simple variety.

THE INTEGUMENTARY SYSTEM.

This is liable to several tubercular affections, which will be described.

The Tubercular Ulcer.—A tubercular ulcer on the skin has features which are very characteristic, and which readily distinguish it from lupus. Dependent usually upon the eruption of a previous tubercular abscess, the causes of which we have seen to be glandular or joint or bone affection, the tubercular ulcer is thus commonly seen in the region of the neck where glandular tuberculosis is most prone to occur, in the region of diseased joints and bones, and in other parts where there has been infection of the skin. Though the tubercular ulcer is in nearly every case secondary, not a few cases are on record where there has been direct inoculation of the skin, as, for example, in the so-called "anatomist's tubercle."

The features which are usual in a tubercular ulcer are: it is irregular in outline, with a thin edge that is not much raised or thickened, but is undermined; the undermining of the edge for some considerable

distance is very suggestive. There is an irregular base, often composed of weak, pale, œdematous granulations, which project above the surface of the surrounding skin and readily bleed when touched. There is a scanty, greenish-yellow discharge. Tubercular ulcers are commonly multiple and confluent; the surrounding skin is of a purplish colour, and bridges and tags are often formed from the undermining and giving way of the skin in various places. The cicatrices, which are generally raised, are hard, pinkish or whitish in colour, and may be puckered and wrinkled; bridges and tags of skin are often associated with tubercular scars.

Infection by inoculation is dealt with at p. 87, and the lesions which such inoculation produces in the skin vary somewhat in character. In some cases an unnoticed abrasion has been the point of entrance. In others the so-called "anatomical tubercle" has been shown to contain undoubted tubercle bacilli. The anatomical tubercle usually occurs in butchers, anatomists, and pathologists engaged in post-mortem work, and is not considered by Treves to be invariably tubercular in character. It most frequently occurs on the backs of the fingers or hands. Where the border of the finger-nails are affected a bluish-red, isolated nodule, tender on pressure, usually develops.

Lupus vulgaris.—This is now recognised as a form of tuberculosis of the skin, and has a special interest as the form of tuberculosis in which Koch's tuberculin was most extensively used. "The distinctive lesion is a new growth in the superficial or deep part of the corium."* "This neoplastic nodule (called by Leloir lupoma) is soft, brownish-red in colour, and translucent, resembling apple jelly." (Hutchinson.) The nodule, like other tubercular lesions, develops slowly. There are two distinct types of the disease, the one

* "Diseases of the Skin." Malcolm Morris.

in which ulceration occurs (lupus exedens) and the other characterised by atrophy (lupus non exedens). Lupus tissue is readily torn and broken down. The disease is chronic, often lasting over many years. Several cases have now been recorded, clearly showing direct inoculation to have been the cause of the onset of lupus; thus tattooing, in which the saliva of a tuberculous operator was used to dilute the ink, and vaccination have both produced the disease at the site of inoculation. In the majority of cases, however, no such clear history of inoculation is obtainable, and it is possible that the bacillus is introduced through some unnoticed abrasion. On the other hand, the tubercle bacilli may be present in the body, and some local condition of the skin may determine the establishment of a tubercular colony, or focus, as is believed to be the case in tubercular disease of the bone. The intimate pathology of lupus, and the precise conditions determining this particular form of tuberculosis, require further elucidation.

The Eye.—The eye may be the seat of tubercular disease, the retina, choroid, and iris all being occasionally sites for the development of the tubercle. Tubercle of the choroid seen through the ophthalmoscope appears as a greyish hemispherical eminence from one to three millimetres in diameter (Juler). In tubercular meningitis detection of tubercle in the choroid occasionally assists in determining the nature of the case.

In conclusion, it may be said that there is scarcely an organ or tissue in the body which is not liable to the invasion of tuberculosis, although it is much commoner in some than in others. The frequency of the occurrence of the disease in the glands, the lungs, and in bone has been pointed out; the organs in which it is, perhaps, most rarely found are the muscles, the pancreas, and the thyroid body.

CHAPTER III.

TRANSMISSION FROM MAN TO MAN.

Heredity—Congenital Tuberculosis—Inherited Susceptibility—Communicability—The Sputum of the Consumptive—Recorded Cases of Communicated Phthisis—The Viability of Tubercle Bacilli in Sputa—Ransome's Researches—Paths of Invasion: Inoculation, Ingestion, Inhalation — Auxiliary Forces of Invasion: Adenoids, Measles, Catarrh, Trauma—Recapitulation.

Heredity.—The whole tendency of modern research into the nature of tuberculosis is to show that the disease is communicable, but not, except in very rare instances, inherited. The only cases in which it can be fairly stated to be inherited are those exceptional ones of congenital tuberculosis—rare both in man and animals. In man, Osler speaks of some nine or ten cases which have been described. In calves, numbers of which are slaughtered, and which thus offer exceptional facilities for observation, Nocard says nothing is more rare than tuberculosis.

Another theory has been promulgated with reference to heredity, and received the strong support of Baumgarten, to the effect that the *latent germs* of tubercle may be transmitted to offspring. Baumgarten believes that "tuberculosis may remain latent under certain circumstances during the whole of life without interfering with living functions in any observable degree," and he considers tuberculosis may be placed in the same category in this respect with leprosy and syphilis. But for the support of such an hypothesis some positive evidence is required, and, as

Ransome * very justly points out, there is no proof that the virulence of the bacillus remains latent for more than a few months; "the heredity of leprosy is still unproved, and the analogy of syphilis to tuberculosis is not yet made out." Congenital tuberculosis being, then, a negligible quantity, and the latent germs of tubercle within the host having but an hypothetic existence, we are compelled to come back to the epigrammatic verdict of M. Peter. "On ne nait pas tuberculeux mais tuberculisable."

In support of the view that a susceptible constitution may be transmitted, a considerable number of observed facts have been adduced. Thus Sir W. Jenner describes a certain type of chest, the essential feature of which is the straightening of the upper ribs, with widening of their intercostal spaces and undue obliquity of the lower ribs, whose intercostal spaces are narrowed. Delicacy of skin, length of eyelashes, fineness of hair, transparency and bluish tint of conjunctivæ, large pupils, precocity of intellect, were all considered by Jenner to be indicative of the tubercular constitution. Tennyson's "May Queen," than whom there was none so fair "in all the land, they say," with her bright eye, brilliant gaiety, and pathetic death, is sometimes taken to be a typical description of the tuberculous constitution. But, on the other hand, how frequently do we see patients suffering from pulmonary tuberculosis obviously not fashioned with that ethereal delicacy of fibre which tradition—begot, perchance, of the bereavement of parents—has associated with the so-called "consumptive tendency." Tuberculosis affects the large in build, the coarse in feature, the dull and the sluggish, as freely as the fairest and the brightest in the land. And if doubt exists about any particular type of constitution being more susceptible than another to the onset of

* *Practitioner*, June, 1898.

tuberculosis, still more does uncertainty arise over the inheritance of such a tendency. Statistics on the subject are far from convincing, and Dr. Walshe, who compiled and analysed 446 cases, finally states that "they do not depose in favour of the hereditary character of the disease." As illustrating the extreme difficulty of eliminating all source of error from an estimate of evidence bearing on this subject, one striking instance has come under my notice in the tragic history of a family who were once well known to me. In this case the father died of phthisis and left a widow with three sons and two daughters, who, with the exception of the eldest son, continued to reside in the house in which the father had died, the eldest son being sent to a boarding school. In the course of some seven years after the father's death the two sons and both daughters residing at home died of pulmonary tuberculosis. The eldest son and the mother were thus the only survivors. For years the history of this family appeared to me a terrible instance of the influence of heredity, and yet, in the light of modern bacteriology, one realises what a false inference this may have been. The one child who escaped was the boy—not exposed for any length of time to infection—who was sent to a boarding school. The four who died were all of them exposed to undoubted infection, as at the time referred to no special precautions were anywhere taken with regard to sputa. Cornet,* of Berlin, gives a number of tables compiled by different men supposed to show hereditary predisposition, and, in doing so, he points out the great difference in the percentages given, which range from 10 to 80 per cent. From these statistics he fairly infers that the term hereditary predisposition is an elastic one. In support of this he goes on to show that in compiling the tables some men deal

* "Die Tuberkulose." Cornet.

only with consumptive parents, others include grandparents, others brothers and sisters of patient, and others brothers and sisters of parents. These, again, are outstripped by those who believe hereditary predisposition to be there when tuberculosis exists in any relative in the ascending, descending, or collateral line. The demands which scientific criticism is entitled to make of statistics are in no way satisfied by such data as these. As Cornet justly says, if the question be narrowed down to whether at the time of conception either parent was actually tuberculous, then something might be hoped for in the way of result.

Communicability. — If there be ground for entire scepticism on the question of heredity, there is none, if a broad and scientific interpretation be placed upon the word, with reference to infection. The evidence on this head is too overwhelming for the most prejudiced person to question, although, as has already been pointed out, there is a danger that a connotation which the word "infectious" undoubtedly had in the pre-bacteriological age of pathology may be unduly attached to it to-day. Proximity to the consumptive, provided simple and methodic precautions are taken, entails no more risk of infection than proximity to a case of typhoid. Both diseases are communicable, but in both the "fons et origo mali" is accessible to the preventive measures of a rationally applied science. We have therefore now to consider the means whereby communication from man to man may, if uninterfered with, be effected, and in later chapters how best to direct interference. Living tubercle bacilli or their spores, or both, are the essential virus. From what sources in man may they be derived? Under what conditions, and for how long, can they exist outside the body?

From the results of Koch's researches already described, we have seen that in all active tubercular lesions the tubercle bacilli are found, and that in the discharges from these lesions the bacilli occur. Thus the sputum in a case of phthisis may be almost a pure culture of tubercle bacilli; the fæces of subjects with tubercular lesions of the bowel, or the discharge of any tuberculous abscess, may also contain them. It is from the sputa of phthisical subjects that by far the greatest danger arises, that from fæces or discharges which are disposed of in sewage being comparatively trifling.

Thus Koch writes:* "It is only necessary to remember that on an average one-seventh of mankind die of phthisis, and that most phthisical patients eject for at least some weeks, often for whole months, large quantities of sputa containing immense numbers of spore-bearing tubercle bacilli. . . . If we further bear in mind the results of Fischer and Schill's experiments, from which it is seen that tubercle bacilli may retain their virulence for forty-three days in putrefying sputum, and for 186 days in sputum dried at the ordinary temperature of the air, . . . a sufficient explanation is afforded of the very wide distribution of the tubercular virus."

The great importance which Koch attached to tuberculous sputa has been confirmed by many other investigators and writers. Dried sputum becomes pulverised, and in the form of dust has been shown to be most virulent. In addition to Koch, Villemin, Tappeiner, and Thaon have experimented with tuberculous dust on animals, producing tuberculosis in the animals experimented on; but the experiment is an extremely dangerous one, and in carrying it out Nocard relates that Thaon contracted

* "Microparasites in Disease," New Syd. Soc., p. 187.

a tubercular broncho-pneumonia which proved rapidly fatal. Straus, in his large work, "La Tuberculose et son Bacille," gives an account of these experiments, and also those of De Thoma, an Italian, who produced tuberculosis in several animals by causing them to inhale dried powdered phthisical sputa. The fate of Thaon was a painful confirmation of the contention, had any such been needed, that tubercular sputa, if allowed to be indiscriminately distributed, are a standing menace to the health of the community at large. In schools, barracks, workshops, cloisters, prisons, offices—wherever crowded common rooms and premises are used—danger from tuberculous sputa arises. If we consider the soldier, the workman, or the city clerk affected with consumption, and after short periods of sick leave returning to his fellows, we shall realise the danger to his fellows which, in the absence of all control of the sputum, must arise.

Many cases of undoubtedly communicated phthisis have been collected by Daremberg. Thus Marfan reported the history of a veritable epidemic of phthisis in a badly ventilated office where 22 men were employed; in four years 13 amongst them died of phthisis.

Arthaud related to a tuberculosis congress the history of a municipal electric works where out of 35 workmen 32 had phthisis; 4 among them were old cases, the 23 others had contracted the disease since their entry to the works.

I have already given a most suspicious history of tuberculosis in a family which came under my own notice. Recently another significant case occurred in a gentleman who has been known to me for many years. He was an employé in a large office in a town in South Africa, and had for years enjoyed excellent health. The great reputation

which South Africa has for consumption had brought many consumptives to this town, which is up-country, and more than one of these consumptives had found a position in the office referred to. There can be little doubt that the disease in this case was communicated to a healthy man in an unusually healthy climate through the dried sputum of the consumptives in the office. The fact is, as Straus truly says, the expectoration of a phthisical subject is almost as deadly as the discharge from glanders in a horse, the difference being that the one is rapid and manifest in its infection, and the other so indirect, so subtle, and so delayed as frequently to escape detection.

THE VIABILITY OF TUBERCLE BACILLI IN SPUTA.

Further experiments on the viability of tubercle bacilli in sputa have recently been made by Ransome.

The great interest of these researches is that Ransome* endeavoured to imitate the actual conditions that prevail in houses or places of public assembly. Statistics show that phthisis chiefly prevails in densely crowded populations, especially where people are packed in badly-drained, low-lying localities, and where the actual living-rooms are filled with organic impurities.

The method of procedure adopted by Ransome was to expose "tuberculous sputum, ascertained to be rich in bacilli and virulent to rabbits," under different conditions, *e.g.* :—

(*a*) In a locality where the soil was dry and sandy, in full daylight or sunlight, exposed to abundant streams of fresh country air.

(*b*) Under similar conditions, in a darkened chamber.

* "Researches on Tuberculosis." The Weber-Parkes Prize Essay, 1897.

(*c*) On a window-ledge "in a small four-roomed tenement in a large town, on a clay soil, without cellarage, and badly ventilated, where several deaths from phthisis had taken place."

(*d*) Under same conditions as *c*, in the dark corner of a sleeping-room. And other similar experiments were made.

These experiments, in Ransome's opinion, "so far as they extend, go to prove that fresh air and light and a dry sandy soil have a distinct influence in arresting the virulence of the tubercle bacilli, that darkness somewhat interferes with the disinfectant action of the other conditions, but that the mere exposure to such light as could be obtained in otherwise bad sanitary surroundings does not destroy the virus."

Another series of experiments was also made, which clearly went to show that daylight and free currents of air rapidly deprive tuberculous dust of its virulence, "that even in the dark, although the action is retarded, fresh air has some disinfecting influence; and that in the absence of currents of air the bacillus retains its power for long periods of time."

With reference to the effect of the drying of sputa, Ransome quotes experiments in which, in the absence of currents of air, the virulence lasted for 130 days. Taking this with the experience of Fischer and Schill referred to by Koch, which gave 184 days, we see the persistence with which dried phthisical sputum may retain its virulence under favourable conditions.

Paths of Invasion.—From whatever source they may come, the tubercle bacilli can only gain access to the body through three different channels:—

(*a*) The skin, by inoculation.

(*b*) The alimentary canal, by ingestion.

(*c*) The respiratory tract, by inhalation.

That *inoculation* with tubercle bacilli may occasionally occur as an accident to man there is strong presumptive evidence to show in the ready inoculability of some lower animals. That it does actually, though rarely, occur in man, there is positive evidence in recorded cases. Koch gives the case of a woman inoculated in the finger with the fragment of a broken vessel which contained tuberculous sputum; tuberculous disease of the finger, necessitating its subsequent removal, followed.

Nocard describes a case of a veterinary surgeon who wounded himself deeply in the thumb of the left hand while making a post-mortem examination on a tuberculous cow. The wound healed well, but six months later a cutaneous tuberculosis was diagnosed at the site of the scar. Pulmonary tuberculosis then developed, and two and a half years after the inoculation the victim of this unfortunate accident died.

Knopf gives several recorded instances of transmission of tuberculosis from a phthisical Jewish rabbi to infants in the rite of circumcision. The most striking is that recorded by Lindemann*: "Two children who were circumcised by a man who was in the last stage of consumption, and who, after the circumcision, sucked the prepuce, according to the Jewish rites, both became infected with ulcers on the prepuce and swelling of the genital glands. One recovered; the other's infection continued, the child developing Pott's disease, and dying finally, after a few years' suffering, from pulmonary phthisis."

Ransome also gives a case of inoculation that came under his notice. It is quite probable that now the etiology of tuberculosis is more clearly understood, still more instances of inoculation will

* *Deutsche Med. Wochenschrift*, No. 30, 1883.

come to light. One has come under my own notice in the case of a house physician in a London hospital, who inoculated himself with tuberculosis at a post-mortem, and subsequently developed pulmonary tuberculosis.

From *ingestion*, or swallowing of tuberculous matter, the chief sources of danger are milk and meat, and these will be considered later. From man the principal dangers of ingestion of tubercle bacilli are incurred—(1) in kissing a tuberculous subject on the mouth; (2) from the contamination of any utensils brought into contact with the mouth of the tuberculous subject, such as spoons, forks, cups, etc., which should always be disinfected after use. By far the greatest danger, as already indicated, is the *inhalation* of tuberculous dust, and this is a constant menace as long as the sputa of phthisical patients are more or less indiscriminately distributed in streets, public buildings, or conveyances, or, in fact, anywhere except in a proper receptacle in or from which they can be effectively destroyed.

AUXILIARY FORCES OF INVASION.

Having considered the sources from which the tubercle bacilli may be derived in man, the conditions under which they may continue to exist outside the body, and the different paths of invasion into a fresh human host, it still remains for us to discuss what circumstances favour, and what oppose, the establishment of tuberculosis with some or all of its train of lesions within that host. When tubercle bacilli are inhaled in the form of dust, they may, as Koch pointed out, like any other inhaled particles, remain in the upper part of the air passages or penetrate into the alveoli. The style of breathing largely determines the result, and the one which most favours a deep

penetration is deep breathing with the mouth open. The nose is important both as a germ-catcher and as a mechanism for warming the inspired air.

Adenoid growths of the pharynx and enlarged tonsils in children, in so far as they produce mouth breathing, thus largely increase the danger from inspired tubercle bacilli.

Reference is made elsewhere (p. 110) to the adenoid growth as an open gate for the direct entrance of tubercle bacilli through the lymphatics to the cervical glands. This condition thus offers a double danger to the affected child, and is undoubtedly in children one of the most important of the auxiliary forces of invasion. In fact, adenoid growth is itself not infrequently tuberculous in origin.

Carious teeth are considered by L. Petit, George Morgan,* and others to be undoubted gates of entry for the tubercle bacillus, and from them they believe the cervical glands are often affected.

When an entrance to the respiratory tract has been effected by the tubercle bacilli, the slow development of the germ, which takes as many days as the anthrax bacillus does hours, offers every facility for its expulsion by the cilia lining the respiratory passages. Specially favourable conditions are thus often necessary before the bacilli can become established even when introduced into the respiratory tract. *Measles*, which for a time denudes the respiratory tract of its protecting epithelium, is thus a contributory condition, and both the absence of the cilia and the frequent presence of bronchial secretion difficult of dislodgement, which offers a suitable nidus to the bacillus, are conditions favouring the development of tuberculosis.

Chronic bronchitis, adhesion of the lungs, and deformities of the thorax—in fact, any condition which may cause circumscribed collections of bronchial

* *Brit. Med. Journ.*, Aug,. 1899.

secretion to accumulate—may, by offering a suitable nidus, favour the establishment of the tubercle bacilli. Thus a number of the cases of phthisis coming on in advanced life, of which many are to be met with in the different "chest hospitals," are those in which tuberculosis has supervened upon a condition of chronic bronchitis.

That the ordinary *catarrh* or *cold* which has "been neglected," or which "sinks down upon the chest," is a condition predisposing to pulmonary tuberculosis, is an old tradition of medicine. How far this may be so it is difficult to say, but it has the strong support of so modern and scientific a writer as Osler, who considers that it may act by "lowering the resistance, or, in modern parlance, reducing the activity of the phagocytes and allowing the bacilli to pass the portals." That catarrh extending to the bronchial tubes should favour the establishment of tubercle bacilli is quite in accordance with the rationale of tuberculosis, and it probably does so, both by lowering the vitality of the tissues, and by offering a condition of bronchial secretion favourable to the development of the bacilli.

All specific fevers, or any other conditions which lower the vitality of the tissues and render them more susceptible, must rank as possible auxiliary forces. Measles has already been referred to as being specially favourable to the establishment of the tubercle bacilli, and *whooping cough*, inasmuch as it produces a bronchial catarrh, is almost equally so.

Malaria, if it does not actually predispose to tuberculosis, is certainly in no way antagonistic, as was once taught, and there is scarcely a large London hospital which does not contain cases of old malarial subjects now suffering from tuberculosis.

In addition to the foregoing conditions which, when they occur in the human subject, may all

become auxiliary forces of invasion, there are other physical conditions of climate, soil, and atmosphere which act both by helping to create these forces and by themselves directly favouring the growth of the tubercle bacillus. Reference has already been made to these physical conditions, and they will be further considered in Chapter V.

Trauma.—Many surgeons emphasise this influence. Some surgeons contend that the production of general tuberculosis sometimes results from operation upon tuberculous lesions. Wartman* gives statistics of 837 resections. Of these, 225 ended fatally, 26 with acute tuberculosis, the outbreak of which was directly associated with operation.

* * * * *

From what has been said we see that the process of transmission from man to man is a clear and a preventable one. The great source of danger is the sputum of the consumptive, which, from the resistant character of the tubercle bacilli with which it is infected, may in the form of dust retain for from four to six months its virulent qualities of infection. In tuberculous dust, the result of carelessly disseminated sputa, the seed is ripe and abundant. In the human host prepared by any of those predisposing conditions described as the auxiliary forces of invasion, the soil is fertile and ready to receive the seed. To destroy the seed, to prevent the preparation of the soil, these are the objects alike of the guardians of public health and the physician.

The breath of the consumptive is free from danger; it has been shown by numerous experiments to be quite devoid of tubercle bacilli, even in the most advanced cases of pulmonary tuberculosis. The danger of contagion which arises in consumptive cases from "kissing"

* *Deutschche Zeitschrift f. Chirurgie*, Bd. 24.

lies in particles of sputum contained on lips and in the saliva, and in the same manner utensils, furniture, or clothes may be contaminated. In writing of tuberculosis, metaphor has been freely used by different writers, and as long as it serves to elucidate the subject there can be no objection to it. The striking parallels which Herbert Spencer and other philosophic writers have shown to exist among all physical and even moral phenomena more than justify this method of description. Where actual conclusions come to be drawn, a strict adherence to ascertained fact is, of course, necessary; but the recognition of this cardinal principle in argument need not prevent the use of a familiar metaphor in illustrating some of the striking features of bacteriological pathology. Old in years and honour is the metaphor of the "seed and the soil." That yet another physical phenomenon, the incidence and development of tuberculosis, should come to be classed in the category of phenomena which this old metaphor so aptly illustrates, is no cause for astonishment. In this instance the sowing of the wind is veritably reaped in a whirlwind of fatal and tragic disease.

The relative importance of the two factors, the soil and the seed, in the production of tuberculosis, requires a final word. There are some who hold that the seed is practically ever present, and that the one essential determining factor is the preparing of a fertile soil, the undermining of the constitution by some one of the conditions already referred to, or by unhealthy environment. That these preparatory processes, these pathological conditions, the auxiliary forces of invasion, are important there can be no doubt, and that the great majority of the cases of tuberculosis would never occur without the presence of one or other of them is certain. But it is also next to certain that where the inhalation of tubercle

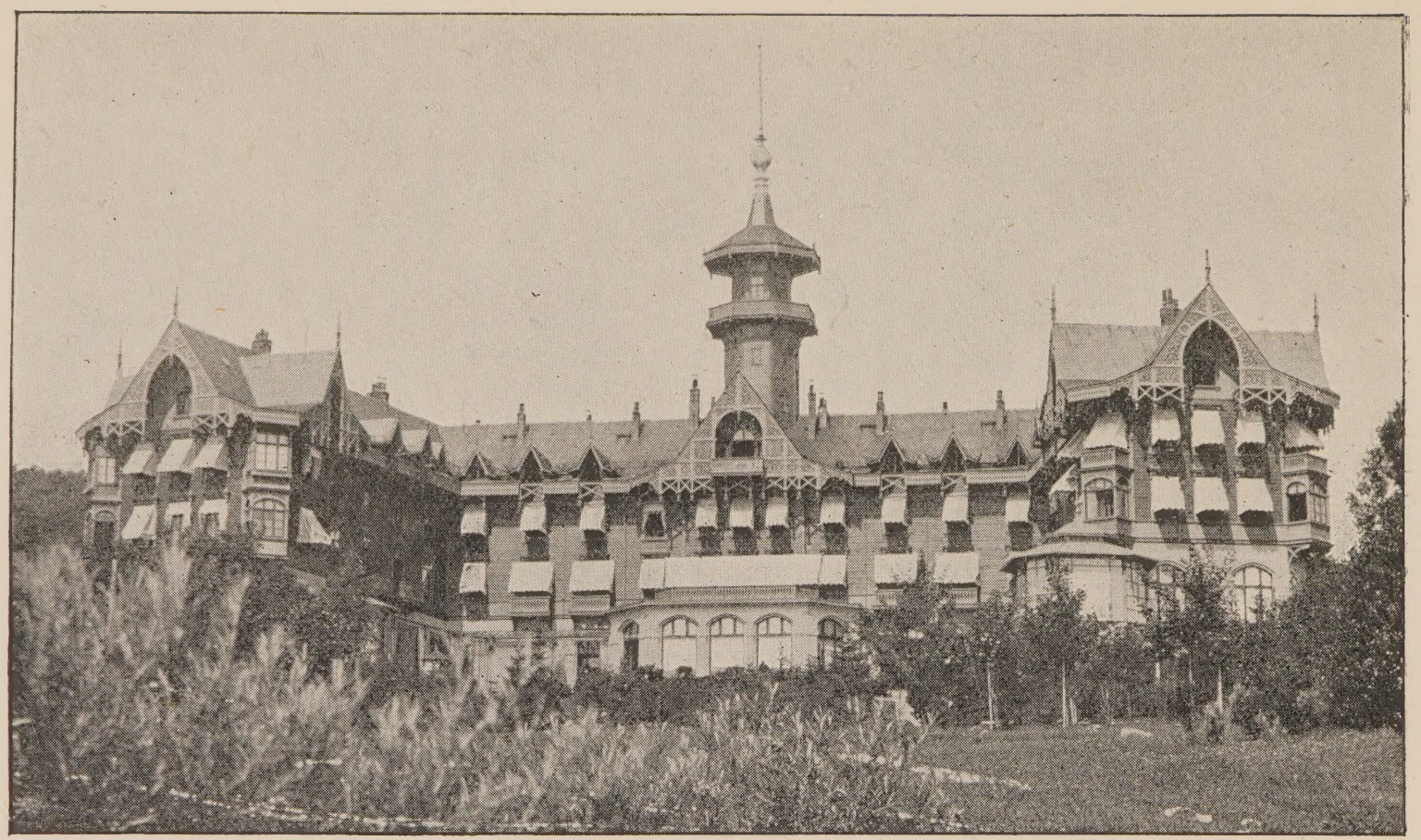


Photo: F. Schilling, Königstein.

Fig. 7.—The Falkenstein Sanatorium.

bacilli occurs in overwhelming quantity, the most robust constitution may succumb.

As Osler points out, there are constitutions which destroy the bacilli at once—"the seed has fallen by the wayside." There are others in which a lodgment is temporarily gained and damage is done, but the protecting forces eventually triumph—"the seed has fallen upon stony ground." Lastly, there are tissue soils where the bacilli, once introduced, thrive and flourish, caseation and softening prevail over limitation and sclerosis, tuberculosis triumphs—"the seed has fallen upon good ground."

CHAPTER IV.

TRANSMISSION FROM ANIMALS TO MAN.

Tuberculosis in Cattle—The First Royal Commission on Tuberculosis—Its Report—Experiments of Experts with Tuberculous Meat—Testimony of Sidney Martin and Sims Woodhead—The Relative Prevalence of Tuberculosis in Different Food Animals—The Second Royal Commission—Tuberculosis in the Pig—In Sheep—Avian Tuberculosis—Cow's Milk—Tuberculous Disease of the Udder—Recorded Cases of Tuberculosis in Children from the Ingestion of Tuberculous Milk—The Relation of Tuberculosis in Milch Cows to Tabes Mesenterica in Children—The Absence of both in Jersey—Protection against Virulent Milk—Paths of Invasion in Man and Animals from Ingested Food containing Tubercle Bacilli.

As from man to man the transmission of tuberculosis is almost entirely by means of inhalation of dried sputum dust into the respiratory tract, so from animals the transmission is almost entirely through meat and milk by ingestion into the alimentary canal Tuberculosis is to be found in a large number of the lower animals, but for the purpose of this chapter it is only necessary to consider such animals as in one form or another furnish food for human consumption. The chief offenders are the bovine race. They and their various products first require consideration.

It has come to be clearly recognised that tuberculosis, whether in man or the lower animals, is a disease principally associated with housing and the crowding in narrow dwelling-places which housing so frequently entails. Thus the Kaffir,* previously healthy, contracts the disease when brought into the native locations of Capetown. The ape, † to whom

* Capetown Med. Officers' Report. † Nocard.

in his native forests the disease is unknown, is stricken with it in the cages of the Zoological Gardens. And so among cattle* it is the stalled ox, the closely-confined and well-fed milch cow, that contract tuberculosis to the extent of nearly 30 per cent.—not the lean steer or heifer wandering unprotected and but poorly fed on an open bleak hillside.

These facts are significant not only in assisting us to understand the etiology of the disease, but also, as will be pointed out, in suggesting the most hopeful and rational system of treatment for the disease when contracted.

In 1890 a Royal Commission was appointed by Her Majesty's Government "to inquire into the effect of food derived from tuberculous animals on human health." In 1895, after hearing a quantity of evidence on every branch of the subject, the Commission presented their Report; and inasmuch as the scientific literature of Europe does not contain a more complete record of experiments than those undertaken for and described to the Commission, I shall deal with the Report at some length, and from its text will be taken such clauses as are of the greatest importance to the consideration of the transmission of tuberculosis from animals to man. Thus the Report reads:—"14. The primary object of the Commission, to learn the effect ot food derived from tuberculous animals upon human health, was obviously one that could not be attained by direct experiment upon human beings. . . . The Commission undertook, therefore . . . inquiries as to the effect of tuberculous food upon the health of lower animals in the expectation of obtaining information applicable to the case of the human subject."

"15. Dr. Martin selected for his experimental research a variety of animals which differed in their

* Harben Lectures, 1898. Thorne Thorne.

customary food material—pigs, guinea-pigs, and rabbits. The animals were fed with their usual foods, with the addition of some material, sometimes meat, much in the sense that a butcher might speak of meat, sometimes milk, but always uncooked, derived from a tuberculous animal. No particular examination for actual tubercle in the food material was made in the experiments now being recorded, but some care was taken to avoid any obvious mass of tubercle."

"16. Of each kind of animal thus fed, a certain percentage was found to become tuberculous—of pigs 35·6 per cent. (5 out of 14), of guinea-pigs 16·5 per cent. (24 out of 145), of rabbits 15·3 per cent. (2 out of 13)."

"17. The experiment comprised also a number of animals kept under the same conditions as the rest (the pigs being members of the same litter), and only differing from the other animals of the experiment by receiving no material from a tuberculous animal in their food. Of these 'control' animals, numbering 5 pigs, 203 guinea-pigs, and 8 rabbits, none became tuberculous."

The dangerous character of uncooked tuberculous meat is here clearly demonstrated.

With reference to the relative prevalence of tuberculosis among different food animals the Report reads :—

"28. The percentage of tuberculous animals (for 1892-3) were, at Berlin slaughter-houses, 15·1 for oxen and cows, 1·55 for swine, 0·11 for calves, and 0·004 only for sheep; and the percentage of the several kinds of animals condemned on account of tuberculosis were, for cows and oxen 1·26, for swine 0·23, for calves 0·06, and for sheep 0·003."

"29. There do not exist for the United Kingdom any records with which these can be compared. At

Copenhagen and Berlin all the meat furnished to the town is submitted to the inspection of experts. But we have reason to think that the facts about tuberculous animals would exhibit a broad resemblance to the foregoing, if such records could be obtained, not more different in degree, that is, than the difference seen between the Copenhagen and Berlin records, or than would be explained by variations in the practice of dealing with food animals in one and another country. Such few data as are to be had for the United Kingdom confirm this view."

For practical purposes, then, we may take the Berlin and Copenhagen rates quoted above as fairly representing the amount of tuberculosis to be found amongst slaughter stock of different kinds. And at a glance it may be seen that by far the greatest extent of animal tuberculosis is to be found amongst cattle, "cattle" full-grown that is, but not "calves." On the rarity of tuberculosis in calves, Nocard cites statistics which point to its occurrence among them being in many places even more rare than amongst those examined at Copenhagen and Berlin. As Nocard * very fairly asks, "Do not these facts show the very feeble part which heredity takes in the propagation of bovine tuberculosis?"

Considering the large number of tuberculous cows, the statistics on this point are most significant. The matter has already been referred to under Heredity (p. 79).

The Commissioners' Report then goes on to consider "Circumstances determining danger to man from meat and milk of tuberculous organs," and their consideration begins with meat.

"38. We have now to point out the very great difference in one and another part of a tuberculous animal in the amount of tuberculous matter contained

* "The Animal Tuberculoses."

in the meat. This matter is found principally in the organs of the animals, as a rule most abundantly in the lungs, lymphatic glands, serous membranes, but often in the liver, spleen, kidneys, intestines, and other structures. These organs are usually removed by the butcher in 'dressing the carcase,' though some of them may, intentionally or not, be left. To a practised eye it is hardly possible that tuberculous matter in these organs can escape detection, and the importance of its presence there will soon be apparent."

If it is from the organs of cattle, then, that the greatest danger exists in meat, to what extent is the ordinary "joint" of the butcher liable to be contaminated?

As a matter of fact, tuberculous matter is seldom found in the meat substance of the carcase. "There is reason to believe that tuberculous matter, when present in meat sold to the public, is more commonly due to the contamination of the surface of the meat with material derived from other diseased parts, than to disease of the meat itself." Thus smearing with a dirty knife just used for removing tuberculous organs is, in Dr. Martin's opinion, a distinct danger.

With regard to the effect of cooking on tuberculous meat, Dr. Sims Woodhead gave some interesting evidence before the Commission. He prepared specimens artificially, "sometimes by injecting tuberculous matter to a known depth into a joint, sometimes by smearing such matter on slices of meat and forming the whole into a compact mass." Such "masses," without the intentional pollution, are known to butchers as "rolls of meat." Feeding experiments were then made with the various portions of meat so treated, and the results at which Dr. Sims Woodhead arrived are comprised in the following conclusions,

and—says the Report—"we do not doubt their accuracy."

"In the boiling and roasting experiments as ordinarily carried out in the kitchen, the temperature, however high it may be near the surface, seldom reaches 60° C. [140° F.] in the centre of a joint, except in the case of joints under six pounds in weight. Ordinary cooking is quite sufficient to destroy any smeared material that remains on the outer surface of the meat, *but it cannot be relied upon in the slightest degree to render innocuous* the same smeared material when in the centre of a roll, . . . especially when the roll is over three or four pounds in weight. The least reliable method of cooking for this purpose is roasting before the fire, next comes roasting in an oven, and then boiling." A clear danger to human health was here indicated, and was recognised by the members of the First Tuberculosis Commission.

In 1896 a Second Royal Commission was appointed to inquire into the "administrative procedures for controlling danger to man through the use as food of the meat and milk of tuberculous animals." They reported as follows: "We are of opinion that the risk to the human subject of acquiring tuberculosis through meat has been very greatly over-estimated; we find no indications of it in the mortality returns dealing with the period of life during which meat has for years past been consumed in increasing quantity in this country, and the only evidence which we know of in the opposite sense, namely, the results of certain artificially contrived infections of meat made for the purpose of the previous Royal Commission on Tuberculosis, was the outcome of deliberately contrived laboratory experiments, admittedly carried out under methods involving a risk greater than any that would probably arise in ordinary trade procedures." What the great over-estimation of risk referred to may have

been is best known to the Commissioners who sat on the Second Commission, but that a real risk does exist there is no reasonable doubt. Positive evidence, which appeared perfectly satisfactory to the First Commission was adduced to that effect, and against it the negative evidence urged by the Second Commission is not, strictly speaking, evidence at all.

The effect left on the mind of the reader of this portion of the Second Commission's Report is hardly likely to induce him to insist on measures with regard to the establishment and supervision of public slaughter-houses. Politicians and local authorities who have to weigh this question will therefore do well to read and consider the finding of the First Commission on this point. No one is likely to contend that tuberculous meat is at all comparable as a cause of tuberculosis with either of the other two great causes, tuberculous dust and tuberculous milk, but to say that the mortality returns "dealing with the period of life during which meat has for years past been consumed in increasing quantity in this country," give no indications of the risk, because presumably the mortality from tuberculosis is on the decrease for the later periods of life, is surely to beg the whole question.

What the mortality returns do show is a big annual death roll at all ages from tuberculosis. What "deliberately contrived laboratory experiments" by Koch and others have shown is that tuberculosis is a communicable and preventable disease due to the tubercle bacillus: hence our Royal Commissions, the one to point out the sources of danger from tuberculous food, and the other to recommend administrative control of such dangers. One of the sources of danger, in the view of the First Commission, was tuberculous meat, and there is practically nothing in the mortality statistics of tuberculosis cited by the Second Commis-

sion to show how many, or how few cases, may have had the tubercle bacillus introduced from this source or from that.

The administrative measures called for in reference to meat will be considered in Chapter V. The point of interest here is that the possibility of infection from tuberculous meat must neither be overlooked nor under-estimated. In this relation, too, it is well to put on record Sims Woodhead's special caution against the risk of raw beef or raw beef juice for children.

Tuberculosis in the pig comes next in frequency of occurrence to that in cattle, and, as we have seen, is given in Copenhagen as being as high as 15·3 per cent.

Thus, as with the "stalled" ox and cow, so in a lesser degree with the pig in his "sty." Filth, darkness, and impure air all favour the development of the bacillus.

Sheep, on the other hand, live in the open, and our mutton is practically free from tuberculosis, as free, in fact, as the "veal" of the calf killed before he has had time to acquire the disease.

Avian Tuberculosis.—Tuberculosis in poultry and game birds is not referred to in the Royal Commission's Report. The incidence of the disease in fowls has, however, given rise to a good deal of speculation and experiment. At first Koch believed the bacillus of avian tuberculosis to be identical with that of human and bovine tuberculosis, but the researches of H. Martin, Straus,* and others have shown that fowls may swallow the dried sputa of consumptives over long periods of time without being affected. Cultures of avian tuberculosis have an appearance distinct from that of Koch's bacillus, and the temperature range

* "La Tuberculose et son Bacille." Straus.

over which a culture may be obtained is much wider. Still further evidence of the distinction to be drawn between avian and bovine or human tubercle bacilli was adduced by Cadiot, Gilbert, and Roget.* They showed that guinea-pigs, so susceptible to human tuberculosis, resist strongly the avian variety. Rabbits, on the other hand, have not the same power of resistance to inoculated avian tuberculosis as guinea-pigs. In later experiments Koch himself recognised that a distinction between the two tuberculoses was to be drawn. The danger, therefore, to human health from avian tuberculosis, if there be any at all, is presumably slight.

Milk from a cow with tuberculous disease of the udder is of all food products the most deadly. At whatever rate the danger from meat may be estimated, about that from tuberculous milk there can be only one opinion. The evidence is overwhelming. The best illustration of this is a quotation from Dr. Sidney Martin's evidence given before the First Tuberculosis Commission: "Of the five tuberculous cows which had udder disease, found on post-mortem to be of tuberculous nature, three showed him tubercle bacilli in their milk. He could not find tubercle bacilli in the milk of the other two. With milk from the three cows fifteen test animals were fed, with the result of producing tuberculosis in every one of them. With milk from one or other of the same three cows, thirteen test animals were inoculated, with the result of all thirteen acquiring tuberculous disease. The milk of the fourth cow (one of those which had not shown tubercle bacilli) was used to feed ten test animals, and produced tuberculosis in four of them. Inoculated into six test animals all of them became tuberculous. The milk

* "Note sur la Tuberculose des Volailles." (C. R. et Mémoires de la Soc. de Biologie, 1890.)

of the fifth cow, in which also no tubercle bacilli had been seen, was used to feed two animals, but without result, yet when it was used to inoculate two other animals both of them acquired tuberculous disease."

The virulence here displayed is nothing less than

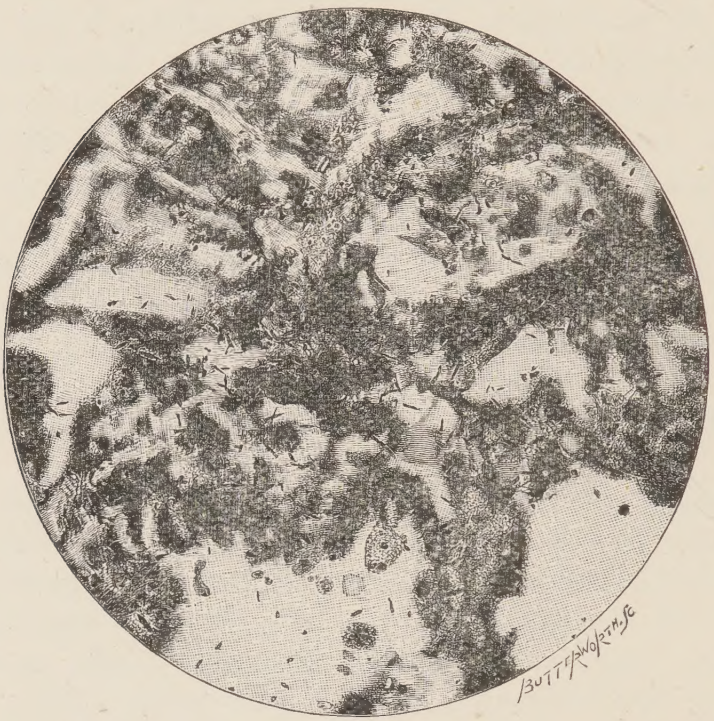


Fig. 8.—Tubercle Bacilli in Cat's Lung. x 600.

extraordinary, but one condition is found to be essential to this virulence, viz., "tuberculous disease of the cow affecting the udder."

Tuberculous disease of the udder may exist, at all events in its early stages, without external evidence even to a veterinary surgeon, and a cow may have severe tuberculosis without the udder being affected, so that the danger is not easy of detection, and renders precautions against it all the more necessary.

To the evidence given as to the virulent effect

of tuberculous milk on test animals, some instances of tuberculosis in human beings directly traced to milk may be added. Thus, Lydtin* relates that Dr. Stang, of Amorbach, attended a well-developed boy of five years old, born of healthy parents, free from tuberculous history. In the course of some weeks the child died of miliary tuberculosis of the lungs, with enormous hypertrophy of the mesenteric glands. While the post-mortem was being made it was ascertained that a short time previously the parents had had a cow slaughtered, which was found by the veterinary surgeon of the abattoir to be the subject of phthisis pommelière. This cow had been a good milker, and for a long time the boy had been in the habit of drinking its milk directly after it was milked.

Here is another case which, as Nocard says in relating it, is almost as convincing as an experiment. Dr. Gosse, of Geneva, whose father and grandfather were doctors, had the misfortune to lose a daughter of seventeen. Up to 1892 she was in perfect health. In 1893 she began to waste away, and ten months afterwards she died. Dr. Gosse, on post-mortem examination, found tuberculosis of the intestine and mesentery. How had the disease been contracted? There was no family history. The localisation of the disease pointed to alimentary origin. It turned out that every week Dr. Gosse's family used to spend Sunday on the hills, at a small estate which he had inherited, and that one of the great delights of this young girl was to drink milk fresh from the cow. On being tested by tuberculin, four out of the five cows on the estate were found to be tuberculous; they were immediately slaughtered, and the autopsy showed that two of them had tubercular disease of

* "Compte rendu du 4me Congrès intern. vet. de Bruxelles," 1883, p. 188. From Nocard.

the udder. Dr. Gosse did not hesitate to bring these facts to the knowledge of his fellow citizens, and armed with them he addressed a letter to the *Journal de Genève*, October 31st, 1893, demanding, in the name of public health, a strict inspection of all cows the milk of which was intended for consumption in its natural state.

The foregoing instances will show the virulent effect of tuberculous milk in individual cases of both animals and man. What light may be gained on the subject from "statistics of mortality"?

The mortality tables prepared by Dr. Tatham, and presented to the Royal Commission on Tuberculosis, 1896, show that from 1851 to 1895 there has been a steady diminution in mortality from "all forms of tuberculosis." But on examination, this reduction of tuberculous disease is found to be far from uniform, and as the late Sir R. Thorne* pointed out, is principally due to a fall in the phthisis rate.

The diminution in deaths from tabes mesenterica, at all ages, is much less. Thus, contrasting the 1851–60 decade with the quinquennial period 1891–95, there is only a trivial decrease, at the rate of 3·0 per cent. for children under 5 years old, while for children under 1 year of age there is an *actual increase of deaths from this cause of* 27·7 *per cent.*

This increased annual tribute is clearly due to infection from tuberculous milk. The consumption of cows' milk is greater in England among children under 1 year of age than it has ever been before, and that milk is principally given to the infants unboiled; tabes mesenterica the effect, unboiled cows' milk the cause, are but too clear.

For the confirmation of this relationship it is only necessary to consider the state of infant mortality from tabes mesenterica in the island of Jersey.

* Harben Lectures, 1898.

On June 9th, 1898, the Jersey Medical Society* appointed a sub-committee "to investigate the prevalence of human and bovine tuberculosis on the island." With reference to bovine tuberculosis, the sub-committee communicated with the veterinary surgeons and the leading cattle breeders, who unanimously expressed the opinion that "there is very little tuberculous disease in the island. Practically all the cattle examined for exportation have successfully passed the tuberculin test."

Dealing with the mortality statistics of St. Helier the capital of the island, with 29,000 inhabitants, the sub-committee found that from 1892 to 1896 only four deaths were registered under the heading of tuberculous peritonitis, or tabes mesenterica. These facts are of the greatest significance.

The Products of Milk.—The risk which attaches to milk extends to all the products of milk in the preparation of which no process of heating is employed. Butter, skimmed milk, butter-milk, cream, and cheese may all contain tubercle bacilli if obtained from a contaminated milk. Thus the First Commission's Report says: "Butter, skimmed milk, butter-milk, obtained from the milk of a cow having a tuberculous udder . . . all contained tuberculous matter actively injurious to test animals." Butter has also been proved by recent researches to sometimes contain bacilli, morphologically not distinguishable from tubercle bacilli and yet which on inoculation do not produce tuberculosis. This non-pathogenic bacillus was discovered by Lydia Rabinowitsch, of Berlin.

Protection against Milk or Milk Products infected with the Tubercle Bacillus.—For the destruction of all tubercle bacilli which may possibly exist in an uncertain milk supply there is one certain

* *Brit. Med. Journal*, Feb. 25th, 1899.

and sovereign remedy. Place the suspected milk over the fire and take it off when it boils. Cream, buttermilk, and skimmed milk may all be treated in the same way.

Dr. Sims Woodhead made numerous experiments for the First Tuberculosis Commission, to ascertain what steps were necessary to sterilize milk as far as tubercle was concerned. His own words describing the chief result were: "The most deadly tubercular material can be rendered absolutely innocuous, so far as any spreading infective disease is concerned, by the action of a temperature at which water boils."

Butter and cheese cannot be boiled. They therefore require in their manufacture some reliably sterilizing process.

Pasteurisation, which is practically heating milk for some time at a temperature below actual boiling, and other modifications of this, such as heat under pressure, have the effect of sterilizing milk without depriving it of its cream-, butter-, and cheese-producing qualities (Chapter V.)

Tuberculosis in Milk Cows.—Statistics with regard to tuberculosis in slaughter stock have already been given, and although alarmingly high, the rate is found to be even higher among milch cows kept in byres for dairy purposes. Thus Nocard says that in stables which have had tuberculosis in them, the proportions of tuberculous cattle is always considerable, and may run as high as 50, 60 or 80 per cent. of the total herd.

The Second Tuberculosis Commission reports: "It has been proved to our satisfaction, from the returns of medical officers of health and meat inspectors, that tuberculosis prevails to a larger extent among dairy stock than in any other class of animal."

The danger to human health from tuberculous

milk is thus a great and serious one, and at present there is actually no power whereby a man may be legally effectually prevented from selling such milk. This question will be considered in Chapter V.

The revelations recently made with regard to this fresh danger, especially to infants and children, from milk, must revolutionise traditions long cherished in the nursery and household.

Until within the last few years, the safest and most nourishing article of food which could possibly be given to a child, was, in the opinion of parents and doctors alike, milk fresh from the udder of a well-kept cow. Boiling was considered quite unnecessary, and by many people objectionable. The change in belief and practice which is now considered necessary is one more of the many instances we meet in life illustrating that profound proverb of an old Eastern sage—

"The altar-cloth of one æon is the door-mat of the next."

PATHS OF INVASION.

As already pointed out, it is quite clear that bacilli "ingested"—swallowed with food—are more likely to affect the alimentary canal than bacilli inhaled, which attack the respiratory organs and passages. Hence it is natural that tabes mesenterica, where the mesenteric glands are the chief seat of the disease, should be especially associated with the feeding of infants and children on infected unboiled milk. The bacilli readily find an entrance through the bowel, which is itself not infrequently ulcerated.

Sims Woodhead* has specially called attention to another channel of invasion, a channel common to both respiratory and alimentary tracts, the throat.

He believes that the tonsils and upper part of the

* *Practitioner*, June, 1898.

pharynx are in all probability much more commonly the points of entrance for the tubercle bacillus from milk than was at one time supposed. The ring of adenoid tissue which guards the entrance to the pharynx, when enlarged in the shape of adenoid growths, doubtless offers special facilities for the lodgment on its folded and often ulcerated surfaces of the tubercle bacilli, and from here they readily pass to the cervical glands. The same thing applies to the tonsils, and through both these gates the bacilli may enter from the milk, and so, having gained access to the glands, produce scrofula.

Sims Woodhead confirmed these views by testing the effect of tuberculous milk on pigs, in which he was able to trace the line of invasion from the tonsils and adenoid tissues of the throat to the neighbouring lymphatic glands, "along the chain of glands in the neck down to the upper part of the thorax, and from this point down to the glands at the root of the lung." In some cases this course of invasion was also accompanied by an invasion through the bowel, to the mesenteric glands, and where a series of animals was killed before the process had gone too far, points were found where the two series of lesions actually met. It is thus clear that tubercle bacilli may be introduced through the throat, either by inhalation or ingestion. Large folded tonsils and adenoid growths offer special facilities for lodgment of the bacilli, and so may become auxiliary forces in both forms of invasion.

CHAPTER V.

PREVENTION IN EVERY-DAY LIFE.

The Possible Sources of Danger—Dust in Houses, Public Buildings, Railway Carriages—Modes of Removal—Conditions Required in a Healthy House—The Flower and the Fungus—Ventilation—Light—The Treatment of Milk, Butter-Milk, Skimmed Milk, and Cream—Butter and Cheese—Meat—Susceptibility to Infection—Inherited Susceptibility—Acquired Susceptibility—Atmospheric Impurity and its Different Forms—Soil—Observations of Ransome and Buchanan—The Care of Children—Herbert Spencer's Advice to Parents—Distinction between Fresh Air and Exposure—The Hardening Theory—Liebig on Food and Clothing—Precautions Necessary with the Consumptive—Control of the Sputum—The Pocket Spittoon an Essential—Spitting.

In the foregoing chapters, the nature of tuberculosis and its communicability from man and animals to man have been considered and certain points of interest made clear.

The disease, practically speaking, is neither inherited nor does it arise spontaneously, every one of the annual 60,000 fatal cases in England, and also of the numerous non-fatal cases, arise directly or indirectly from a pre-existing case either in man or beast. The sources of origin, the channels of transmission, and the actual paths of invasion of the tubercle bacillus have been indicated, and certain conditions or forces auxiliary to such invasion pointed out. The facts adduced may be held to point a moral, viz. that every educated and intelligent man or woman to-day should have some knowledge of the rationale of this disease, and on that knowledge should base the conduct of his or her household so

as to avoid certain well-defined and avoidable risks. In estimating these risks, the present imperfect condition of the statutory law of the country, as well as the erratic and imperfect application by local authorities of such laws as are in existence, require to be borne in mind. What amendments of the present law, and also what regulations as to the law's application, are demanded in the interests of public safety, will form the subject of the next chapter. A consideration of practical measures accessible to every householder or private individual, and indicated by the logic of facts, will form the subject of the present one. Destruction of the seed, sterility of the soil, are the objects to be attained. The possible sources of danger, the vehicles by which the tubercle bacilli may be conveyed, are, as already shown, practically confined to—(*a*) Dust; (*b*) Milk, including butter-milk, cream, or skimmed milk; (*c*) Butter and Cheese; (*d*) Meat.

Dust may be held to be any matter capable of being taken up and suspended in the atmosphere. It may be animal, vegetable, or mineral in its origin, and exist either in visible particles, or in powder impalpable as air itself. That the greater portion of it is unpolluted with germs of disease is fortunate for the continuance of higher animal life on the earth; but, nevertheless, it is capable of conveying, and probably does convey, either as minute particles or attached to such particles, nine-tenths of the micro-organic parasites which propagate disease.

The micro-organisms most likely to be conveyed vary with different climates and environment; thus, while the tubercle bacillus is, under existing conditions, probably the most common contagion present in the dust of European cities, the pneumococcus is probably more so in certain sub-tropical and tropical countries—as, for instance, the towns of South Africa,

where "dust pneumonia" is one of the most common fatal diseases. At present, perhaps, not sufficient is known of the pneumococcus, outside the body, to warrant a positive assertion of its presence in dust, but arguing from analogy, and the epidemics of pneumonia associated with dust, it is more than probable. The bacillus diphtheriæ is undoubtedly at times a dust-borne as well as a water-borne contagion.

To prevent the accumulation of dust in a house is highly desirable; nevertheless, where infected dust is not created within the house itself, to prevent the possibility of its entrance from outside is impracticable. Through every open door, window, or crevice dust finds an entrance. But currents of air, even if they bring dust in, also carry it out, and are far less dangerous than the unchanged air of a house soon becomes. There are a hundred other ways in which dust is carried into a house, on boots, clothes, rugs, etc. The rug, for instance, thrown over the feet in a railway compartment, is undoubtedly particularly liable to be contaminated with dust, of not infrequently a dangerous character. For, owing to the filthy condition in which many railway carriages are continually kept, polluted dust may remain in them for a considerable period of time, and become a source of real danger to the travelling public. The habit of expectoration on the dusty floor of a public conveyance is not yet extinct, and the consumptive is a frequent traveller. The dusty condition of railway carriages is a public scandal. On the highway, in public buildings and conveyances, in the house, go where we may, dust is continually present, and so long as sputa are disseminated undestroyed, will remain a source of constant and serious danger, as a means of propagating tuberculosis.

The disposal of sputa is, of course the crux of the

whole question. It is discussed at the end of this chapter.

The next important step is the careful removal of dust itself, wherever it accumulates, in places, such as houses, public dwellings and conveyances, which are frequently filled, or at least occupied, by human beings. And in the removal sufficient moisture should be used to prevent, as much as possible, dust flying about and settling elsewhere. Thus damp dusters, and some form of dusting-machine which picks up and carries off the dust, are the best articles for domestic use.

Conditions Required in a Healthy House.—In spite of all rational precautions, it is evident that tubercle bacilli may gain access to any house or room, and such a lodgment once having been effected, the important question for consideration becomes, What are the conditions which favour, and what those which militate against, the retention by such bacilli of their vitality and virulence? Fortunately, the special measures demanded in a house for producing the conditions destructive to the virulence of any stray tubercle bacilli which may have effected a lodgment there, are those best calculated to preserve and improve the general health of the household. Thus, air, light, sunlight where obtainable, and dryness render the individual better able to resist the establishment of tuberculosis, and at the same time are the conditions most destructive to the vitality of the tubercle bacillus.

The direct experiments on the effect of these influences on the virulence of tubercle bacilli made by Dr. Ransome have already been quoted (p. 85).

Both Koch and Ransome have shown that the influence of direct bright sunlight on tubercle bacilli is to destroy their vitality in a few hours.

The child or adolescent may be compared to a

flower that blossoms and thrives in sunshine, light, and pure air; the tubercle bacillus is not even metaphorically, but actually a fungus, that thrives best in dirt, gloom, and foul atmospheres. The house must be adapted to the one and not to the other. Many houses even of the middle and upper classes are better adapted to the fungus than the flower, while

Fig. 9.—Shelters in the Woods, Dr. Brehmer's Sanatorium, Görbersdorf.

the small, narrow, crowded tenements of city slums and alleys are always so.

Ventilation.—Air, dryness, light being desired conditions in a house, one of the first considerations is the much-vexed one of ventilation. An admirable leaflet dealing with this question has been published by the National Association for the Prevention of Tuberculosis, and may be found in the Appendix. The open window, day and night, is as essential to the prevention as it is to the cure of the disease. No one should remain for any length of time in a room, reading or working, without an open window.

The stuffy room, no matter how large, with curtains and sandbags, is unhealthy. A direct cold draught may be avoided with a little manipulation of a screen or a window sash. The air appetite is soon acquired and appreciated by people who keep pure air in their house and dwelling-rooms. The significance of fresh air in the prevention and cure of tuberculosis is considered in Chap. VII.

Dryness in the house varies partly with the foundations and other structural arrangements of the house, partly with the nature of the soil.

The house once selected, the two chief resources at the disposal of the householder for keeping his house dry are free ventilation, and a rational system of heating in cold weather. Fires have always one advantage over any other system of heating: they ensure a current of air through the room, the chimney forming a free ventilating shaft, especially when in actual use.

Light.—Air and temperature in a house may be in a measure regulated by the dweller in it after the house is built. In the matter of light, unfortunately, he is principally dependent on the locality, position, and architectural structure of his dwelling.

In selecting a house, the importance of light is frequently under-estimated. In such a climate as ours, the advantage to health, and the pleasure of a bright southern aspect, whether in town or country, are incalculable. In building a detached house in the country, it is best to make it face either south-east or south-west, so that the back rooms may have some degree of sunlight each day.

Windows should be fairly large and plentiful. Where windows are impracticable, skylights should be placed at the heads of staircases, and in corners which would otherwise be dark.

These recommendations may scarcely seem neces-

sary, and would not be inserted here were it not for the fact that dark houses are still daily being constructed.

Milk — *Butter-milk — Skimmed Milk — Cream.* —Next in importance to dust as a vehicle wherein the seed—the tubercle bacilli—may be carried, and perhaps in children even transcending it in importance, come milk and its products. With regard to them we are, however, at this advantage as compared with dust: under present circumstances the danger from the dust is only partially controllable—only capable, in fact, of being minimised; the danger from milk is capable of absolute control.

Milk, butter-milk, skimmed milk, and cream are all capable of being boiled. If brought to the boiling point of water for the space of only a few seconds, they are entirely sterilised and rendered innocuous. But even less than this will sterilise milk. If milk and cream be placed over the fire in a saucepan, which stands in another one filled with water, until it has reached a temperature of 90° C., and be kept at this temperature for five minutes, the sterilisation will be complete. That is, for practical purposes the boiling of the water in the outer saucepan for the space of some minutes will serve the same purposes as actual boiling of the milk. At the same time, it is certain that there is no method so safe, certain, and clear as to place the milk on the fire and take it off when it boils, and for *nursery purposes* this is the one that should invariably be adopted. Sir R. Thorne Thorne, in his Harben lectures, speaks out very strongly on the subject of boiling milk. Thus he says: "We find people apparently intelligent, including even the heads of young families, who discard this means of prevention on the mere ground of 'taste.' And what is still more striking and reprehensible is the fact that in many of our hospitals

established for the cure of disease, no effort is made to avoid in this way the chance of imparting tuberculosis, merely because the effort would cause some inconvenience. The avoidance of all that is septic in connection with surgical operations stands in striking contrast with the courting of infection in the wards by the use of uncooked milk." *

The taste of cooked milk, to which a child or adult is soon reconciled, may be reduced almost to nil, (1) by heating the milk as above described to a temperature of 90° C.; (2) by placing the milk, boiled after the morning delivery, in the cool for use in the afternoon, and treating the afternoon's milk similarly for morning use.

Another objection urged is that boiled milk is not so digestible for children. A long experience of its use as a diet for infants has convinced me that this is not so. It is true that it may occasionally produce a certain amount of constipation, but this may be readily overcome by the addition of two or three grains of sulphate of magnesia in the bottle.

Another point to be borne in mind in connection with the boiling of milk is that its substitution for raw milk as an article for food has not only the advantage of abolishing all danger from tuberculosis. Boiling destroys all other disease germs, a large variety of which may, and undoubtedly occasionally do, by some accident or neglect of proper dairy precautions, find their way into milk.

Of course, no milk, however treated, can equal for infants' food purposes the milk from a healthy human breast. Milk from this source is more nourishing, and almost invariably free from tubercle bacilli. Tuberculosis of the human breast is very uncommon.

As long, then, as tuberculosis exists among cattle,

* Harben Lectures, 1898.

the boiling of cows' milk is a precaution necessary in all kitchens and nurseries; but, nevertheless, the consumer very justly feels that he is entitled to expect, and that the law should enable him to demand, a pure article, free from any taint of tuberculosis or other contagion, from the dairyman of whom he obtains his supply. In the present state of the law, the consumer's only remedy is to obtain milk from a dairyman who guarantees that the tuberculin test * is used periodically among his cattle, and that none but perfectly healthy animals are kept in his herd. Several dairies and dairy companies now offer this security, and all public institutions, hotels, etc., should be able to ensure their clientèle that their milk is obtained from such a dairy. If public institutions as well as householders adopt this course, the present evil will in a large measure remedy itself, for the simple reason that any dairyman who does not offer the guarantee will lose his customers.

Butter and Cheese.—Both butter and cheese are milk products, and though the risk of infection from them is considerably less than from milk itself, which is taken, especially by children, in much larger quantities, a risk does exist. On this point investigators are agreed. Thus with reference to butter, the First Tuberculosis Commission's Report has already been quoted (p. 107).

Macfadyen refers to tubercle bacilli in butter,† and Bang, Galtier, Hein, and Gasperini have shown that "both butter and cheese may keep alive for a long time the tubercle bacilli which were contained in the tuberculous milk used in their manufacture." To obviate this risk, the Pasteurisation of milk and cream, which is now in general use in Denmark, is

* For consideration of tuberculin test in cattle, see Appendix.

† "The Relation of Tuberculosis of Animals to Man," by Allan Macfadyen, *Practitioner*, June, 1898.

called for. Pasteurisation consists practically in a process of heating, at a temperature short of actual boiling, for a period of time sufficient to ensure the destruction of the bacilli, and a temperature of 85° C. for five minutes accomplishes this. In England a process of scalding cream is used in the preparation of Devonshire butter and cheeses, which practically ensures sterilisation, and a guarantee of this or some other process of sterilisation should be demanded by the consumer from the dairy supplying him with butter and cheese.

Meat.—Dr. Sims Woodhead's evidence with reference to the possibility of tubercle bacilli deeply buried in a "joint" or "meat-roll" surviving the cooking process has already been quoted (p. 99).

The risk does not appear to be a great one, but it cannot be entirely ignored, and the householder who desires to minimise it may do so by obtaining meat of a butcher who has his stock slaughtered at a public slaughter-house or abattoir where inspection is periodically carried out.

SUSCEPTIBILITY TO INFECTION.

Having considered the various means by which the tubercle bacilli may be conveyed, and the measures best calculated to destroy their vitality or prevent their introduction to the human subject, it will be well to review conditions in and around the subject which favour, or are hostile to, the establishment of tuberculosis when once the bacillus has been introduced.

Certain pathological conditions, described as auxiliary forces of invasion, which may favour the development of tuberculosis in anyone suffering from them, provided the tubercle bacilli are introduced, have already been referred to; but there are other

more general constitutional conditions which are held to render one individual more susceptible than another, and also certain general physical conditions of atmosphere and environment which tend to induce susceptibility. Susceptibility may, then, be conveniently divided into inherited, and acquired or induced, susceptibility.

Inherited susceptibility was discussed under Heredity (p. 80), and need here only be briefly referred to. The extent to which it actually exists has been the subject of controversy recently, though there can be little doubt that any inherited weakness or deficient vitality of constitution probably renders the subject of it more liable to succumb to the invasion of tubercle bacilli as well as to that of any other microbes. That there is any greater susceptibility in certain cases to the tubercle bacillus than to other disease microbes is a point on which no clear evidence is forthcoming, although, looking to the extent of variation in all inherited characters, this is quite probable. Special precautions against exposure to the danger of infection are required in all weakly children.

Acquired or Induced Susceptibility.—As already shown, the physical conditions most calculated to favour the continued existence of the tubercle bacillus outside the body are those most active in so undermining human health as to induce susceptibility to infection.

The foul air and darkness of overcrowded tenements in courts and alleys produce the pallid, weakly denizens of the slums, among whom the mortality rate from tuberculosis, in its various forms, stands so high. As indicating the intimate association of tuberculosis with crowded, ill-ventilated dwellings, Sir Henry Littlejohn * quoted some statistics which

* *Brit. Med. Journal*, 1898.

directly showed that, in Edinburgh, the poorer the class of tenement the higher is the mortality from phthisis among the occupants.

There are three forms of atmospheric impurity which specially tend to induce susceptibility to phthisis and other respiratory diseases. They are: (*a*) respiratory impurity of atmosphere; (*b*) impurity from dust of organic origin; (*c*) impurity from dust of metallic origin.

These different forms of atmospheric impurity are specially associated with different occupations; thus organic impurities occur in the manufacture of textile fabrics, metallic dust among metal workers, and respiratory impurities in all crowded factories, and especially in the cramped, ill-ventilated quarters of compositors and bookbinders. Summing up the result of certain interesting investigations which Kerr Chalmers* made, he says, "While phthisis forms nearly 39 per cent. of the metal worker's respiratory diseases, it forms no less than 57 per cent. of the class to which the bookbinder belongs. Proportionately, therefore, atmospheric impurity from respiration alone must be regarded as ranking high among the single causes which predispose to phthisis; and, while the other forms of impurity increase this predisposition, to an even greater degree do they increase the susceptibility to the other forms of respiratory disease."

The prevention, or at least the diminution of the occurrence of these conditions, chiefly the result of overcrowded workshops, will come under consideration in the following chapter, but statistics so strongly emphasise the importance of a "pure atmosphere" as one of the precautionary measures against tuberculosis, that they deserve the attention of every householder.

* *Practitioner*, June, 1898.

Soil.—Of all the physical conditions of environment there is none which has a more decided influence on the occurrence of phthisis than soil, and it probably acts not merely on the susceptibility of the individual dweller, but also directly upon such tubercle bacilli as may temporarily be lodged upon it outside the human host. It therefore becomes a doubly important factor. Dr. Ransome made an inquiry into this subjcct, an epitome of which is given in the *Practitioner* for June, 1898. It was a contrast between two populations—one on clay lands, the other on a hill of sand. "The results were derived from two series of mortality returns, one for the nine years 1875–84, the other for the succeeding nine years. Of the first group twenty-two deaths were from phthisis, but all of them took place on certain low-lying clay lands which surrounded a hill of sand, and nine of the remainder were found by inquiry to have contracted the disease before coming to the place. This left only two to be accounted for. One of them was a gentleman who spent the greater part of his time in a neighbouring town, where he had frequently to attend crowded evening meetings; the other was a merchant's clerk, who went to town at eight every morning and did not return till 7 p.m. No woman or child died of the complaint. The disease, therefore, did not originate in any of the stationary population resident during the nine years upon the sandy portions of the district." The results obtained in the second group were strikingly similar.

Dr. Buchanan, when chief medical officer to the Local Government Board, expressed himself clearly and strongly on the subject. The following are some of the conclusions he arrived at:—

(1) Within the counties of Surrey, Kent, and Sussex there is, broadly speaking, less phthisis among

populations living on pervious soils than among populations living on impervious soils.

(2) Within the same counties there is less phthisis among populations living on high-lying pervious soils than among populations living on low-lying pervious soils.

(3) Within the same counties there is less phthisis among populations living on sloping impervious soils than among populations living on flat impervious soils.

(4) But the connection between wet and phthisis came out last year in another way, which must here be recalled—by the observation that phthisis had been greatly reduced in towns where the water of the soil had been artificially removed, and that it had not been reduced in other towns where the soil had not been dried.

(5) The whole of the foregoing conclusions combine into one—which may now be affirmed generally, and not only of particular districts—that "wetness of soil is a cause of phthisis to the population living upon it."

Dr. Bowditch, of Massachusetts, Dr. Haviland, and the Registrar-General of Scotland all write in similar terms. In fact, so largely has the importance of dry, sandy soil for residences come to be appreciated in recent years that all building sites on sand near London have risen to a great extent in value, and in seeking a site for the London Open Air Sanatorium I had great difficulty in finding one so situated, at anything but prohibitive prices. Thus the upper and lower green sand belts which run through Surrey are rapidly being taken up and built upon, and Dorking, Godalming, and Guildford are becoming the centres of large suburban districts. The statistics and reports quoted emphasise the high importance of a dry, well-drained "underlie" as a precautionary measure against tuberculosis.

The Care of Children.—With reference to precautions desirable in controlling the food supply of children, enough has already been said under milk and meat (*vide* p. 117), and the risk incidental to raw beef and raw beef juice was also commented upon. The necessity for precautions requires to be well borne in mind, as the alimentary tract of a child is undoubtedly more susceptible to invasion by the tubercle bacilli than that of adults. With children fresh pure air is of the utmost importance. The nursery window should be opened at night after the child is once in bed, and through the day windows should never be entirely closed. The bedroom or nursery window should be closed while the occupant of a room is dressing or undressing, if the outer air is cold. Certain anomalies exist in the dress of children, which, inasmuch as they lower the vitality and increase the liability to catarrhs, may indirectly favour the establishment of tuberculosis. Pure air in abundance, both in the house and out of it, is the first consideration, but with it must be combined a rational method of clothing children, and so protecting them from exposure to cold. Herbert Spencer, in his classic little work on "Education," which he divides into intellectual, moral, and physical, and which should be read by every parent, especially dwells, in considering the physical side of education, on the necessity for warm and sufficient clothing, and the folly of so dressing children as to leave them with naked legs. This custom, extending as it does to all classes of the community, is attended with discomfort and detriment to the victims of it, and Spencer clearly maintains that, where no positive illness is produced, there is an additional call upon the tissues of the body in which an undue degree of waste or consumption of tissue is kept up in order to provide the extra amount of heat necessary to a child

so under-clad. In this way the exposure may cause actual stunting of growth.

Personal observation has convinced me that this custom amongst children increases both the frequency and the duration of catarrhal attacks, as well as of such diseases as croup, tonsillitis, and adenoid growths of the pharynx, all of which may become contributory causes to the establishment of tuberculosis.

The practice of under-clothing children is based on a false idea of hardening a child's constitution, and on this fallacy Spencer writes as follows:—

"To make up for that cooling by radiation which the body is ever undergoing, there must be a constant oxidation of certain matters forming part of the food. And in proportion as the thermal loss is great, must the quantity of these matters required for oxidation be great. But the power of the digestive organs is limited. Consequently, when they have to prepare a large quantity of this material needful for maintaining the temperature, they can prepare but a small quantity of the material which goes to build up the frame. . . . Hence the great importance of clothing."

Liebig writes: "Our clothing is, in reference to the temperature of the body, merely an equivalent for a certain amount of food."

People fail to discriminate between fresh air and undue exposure. The one is as advantageous as the other is harmful.

The clothing used need not, and should not, be heavy; if made with a proper amount of wool, the greater the proportion of wool the better, it will be warm. Man is born naked into the world, and for his health and comfort requires to be covered. To only half-cover a child at the most tenderly susceptible period of his existence is as unreasonable as it is dangerous.

At the same time, the other extreme of enveloping children in apparel so heavy and abundant as to induce profuse perspiration, and by this means chill is equally reprehensible.

PRECAUTIONS NECESSARY WITH THE CONSUMPTIVE.

Consumptives are neither isolated nor publicly notified to the authorities. A consumptive may reside in a private house, a hotel, an ocean steamer, in fact, anywhere, and the practical conduct of his case remain entirely in the hands of himself or his friends. And when it is borne in mind that in the sputum of the consumptive the chief danger to the public health exists, it will be readily recognised how vitally important the conduct of the consumptive patient is. One of the first duties of a medical man dealing with a consumptive patient to-day is to see that the patient is properly instructed in the measures rendered necessary to his own and the public health by his condition. At some chest hospitals simple printed instructions are issued to patients, although, as a general rule, these institutions have not yet recognised the great responsibility resting on them, especially with reference to their out-patients, in this matter. An excellent leaflet, dealing with simple practical measures for the prevention of tuberculosis, has been published and distributed by the National Association for the Prevention of Tuberculosis; *vide* Appendix (p. 226). All linen, etc., used by the consumptive should be well boiled before being sent to the wash.

It cannot be too strongly emphasised that if the sanguine hopes of exterminating tuberculosis are to be in any large measure fulfilled, the absolute control of the sputum of the consumptive must be gradually insisted on, and the use of the pocket spittoon, and

other precautionary measures, become a routine practice with a phthisical patient, whether he be in a sanatorium, a lodging-house, a private dwelling, or anywhere else. As already pointed out, although the establishment and development of tuberculosis is more indirect, more delayed, and more subtle than

Fig. 10.—Baildon's and Allen & Hanbury's Sputum Bottles. Dettweiler's Pocket Spittoon.

Of these three pocket spittoons Dettweiler's is the neatest and most complete, but the most expensive.

that of glanders, the expectoration in the one case is as deadly as the nasal discharge in the other.

Spitting in Public Places.—In addition to controlling the sputum of the consumptive, all spitting in public places should be repressed by the pressure of educated public opinion. In many schools in France spittoons are now provided, and their use insisted on. The same practice should be followed in all barracks, workshops, and crowded offices. In fact, phlegm must come to be regarded with the same sentiment as urine or any other excreta from the body. It is impossible to say when phlegm may begin to contain tubercle bacilli. The time will undoubtedly come when all spitting, except into a

spittoon or drain, will be regarded and treated as a public nuisance.

It will be tolerably clear, from what has already been written, that consumptives of both sexes, and all classes, should recognise that they are called upon to entirely adapt their lives, for the sake of themselves, their families, and their neighbours, to the requirements of their disease. The precautions necessary to minimise the risk of further propagation of the disease in the consumptive and his fellows have been considered, and in order both to facilitate these and to give the sufferer the best chance of recovery, it is highly desirable that the open-air treatment should be adopted. The best introduction to this which a patient can possibly have is a residence of some months in a sanatorium conducted on open-air principles, and it is to be hoped that ere long these will be available for every class of the community. The benefit derived from a stay in such an establishment is not merely the improved health of the patient; it is largely the education, which teaches him that some of the measures and precautions most desirable for his own welfare are also an essential part of his duty to his neighbour.*

* Some admirable "Points for the People" are given by Newman in his recent work, "Bacteria," pp. 290–3.

CHAPTER VI.

PREVENTION BY LEGISLATION AND PUBLIC ACTION.

The Present Laws offer no Protection against Tuberculosis—Should they not do so?—The Second Royal Commission on Tuberculosis—Extent of Tuberculosis in Dairy Stock—Inspection of Meat—Varying Practice and Standards—Public Health Acts—Ludicrous Qualifications of Meat Inspectors—"Chaos is the only Word"—Necessity for Skilled Meat Inspectors—Public Slaughter-houses—The Scotch is the best and most efficient Public Health Act—Abuse of Private Slaughter-houses—Practice in the best Continental Abattoirs—Compensation to Owners of Condemned Carcases—Insurance, Contribution from Local Authorities—Milk Supply—Local Authorities Powerless to Prevent the Sale of Milk drawn from Diseased Cows—Tuberculous Disease of the Udder—The Recommendations of the Commission—Notification of Udder Disease: a Totally Inadequate Measure—No Tuberculous Animal should be Allowed to Remain in a Dairy—Isolation, not Destruction—What might be done with the Milk of Reacting Cows—The Australian Colonies have Solved the Problem—Notification of Phthisis: Compulsory or Voluntary?—Factory Acts—Housing of the Working Classes Act—Paris behind London—Lord Rowton and Rowton Houses—The Airing of Cities.

TUBERCULOSIS being a communicable disease, transmitted chiefly, if not entirely, through the sputum of the consumptive, the meat of tuberculous beef, and the milk from a tuberculous cow, it is now necessary to consider what measures of protection may be afforded to the public by the law of the land. The present position is at least clear. The dairyman* could wittingly and deliberately, up to 1898, provide his customers with milk containing tubercle bacilli direct from the tuberculous udder of his cow. This power is to-day only slightly

* Paragraph 38, Report of Second Tuberculosis Commission, 1898.

restricted by the recent "Order" of 1899, which provides that milk from a cow certified by a veterinary surgeon to be suffering from tubercular disease of the udder shall not be sold for human food, under a penalty of £5. But only externally discoverable udder disease is here guarded against. The butcher,* when he desires to do so, has little difficulty in disposing of tuberculous meat, either by using a private slaughter-house, where there is practically no inspection at all, or by using a public one, where the decision as to the condition of the meat is left to the leisure time of a "tram conductor," a "florist," a "bricklayer," or some equally unqualified person. The consumptive expectorates—generally, it is only fair to say, in perfect innocence of the mischief the act may cause—wherever, limited by the habits of sex and class, may be most convenient.

The public are therefore fairly entitled to ask whether the laws in existence, professedly to guard the public health of the community, may not be either invoked or added to so as to afford some measure of protection from one of the greatest preventable evils the world has yet known. And the consideration of this problem constitutes the substance of the present chapter.

"The administrative procedures for controlling danger to man through the use as food of the meat and milk of tuberculous animals" formed the subject of the inquiry of the Second Royal Commission, who reported to Parliament in March, 1898. This Report was accompanied by certain recommendations, which, with the Report itself, will first be considered. The feasibility of public or legislative action with reference to the consumptive himself will then be dealt with. In the body of the Commission's Report

* Paragraph 21, *ibid.*

evidence is quoted as to the reliability of the tuberculin test for detecting tuberculosis in cattle, to which the Danish expert, Bang, and Professor McFadyean both testify; while the prevalence of tuberculosis among British and Irish dairy stock is dealt with, as the following significant extracts will show:—

"Overwhelming evidence proved the greater prevalence of tuberculosis among dairy stock than among bullocks or heifers, owing, no doubt, to the close confinement of cows during a great part of the year, sometimes throughout the year, to their greater average age, and to the severe drain on them caused by milking. It is a common practice with cowkeepers to maintain a high temperature in the byres, which is rarely found associated with efficient ventilation."

"While we do not share the opinion that the breed or race has much to do with liability to tubercular disease, neither do we gather from the mere preponderance of tuberculous cows that there is a greater inherent liability to infection in the female than in the male sex. This is exceedingly important in view of the organised attempt which we trust may be made to get rid of the disease. Tuberculosis is almost unknown among those cows which are kept chiefly in the open air. In Jersey and Finland the native cattle are reported to be almost wholly free from tuberculosis, though they are just as susceptible as others to be attacked when brought within reach of infection."

Of the gravity and widespread character of the disease among cattle it is clear from the above that the Second Royal Commission were as fully convinced as the First.

INSPECTION OF MEAT.

With reference to the inspection of meat, the greatest differences in practice obtain in different towns, and the standards by which meat is considered fit or unfit for food vary with the zeal and knowledge of different inspectors.

The provisions of the general law with regard to

meat inspection in England and Wales outside the administrative County of London are contained in the Public Health Act, 1875, and the Acts incorporated with it.

London has an Act of its own, the Public Health (London) Act, 1891. It is on the same lines as the Public Health Act, 1875.

Ireland and Scotland also have separate Acts, that of Scotland being the best.

Meat inspectors are appointed by the sanitary authorities in different places, and there is a total absence of uniformity in the special qualifications required by them.

Thus, "in Hackney the duties have been committed to two plumbers, one carpenter, one compositor, one bricklayer, one florist, one builder, one surveyor, and one stonemason."

In the Edinburgh public slaughter-house meat inspection is carried on "more nearly on the enlightened system of the best continental abattoirs." "Here there are six meat inspectors, of whom four are veterinary surgeons, one has been a butcher, and one a cattle salesman."

On the working of the present system the Report reads:—

Paragraph 22.—"As to the amount and distribution of tubercular disease which justifies the seizure and condemnation of a carcase as unfit for human food, the widest discrepancy prevails in opinion and practice. *Chaos is the only word* to express the absence of system in the inspection and seizure of tuberculous meat, and it has, in our opinion, become necessary that regulations should be formulated for the guidance of those who are concerned in dealing with this subject.

"In Belfast the presence of tuberculosis in any degree is held to be ground for seizure; on the other hand, in Islington the veterinary inspector of the Corporation of the City of London only seizes those carcases wherein tuberculosis is generalised and the meat in poor condition. In Dublin the medical officer of health used to seize on the slightest evidence

of tuberculosis, but he has recently modified his views, and only seizes carcases which are somewhat extensively affected.

"In Sheffield seizure is made of a carcase showing the slightest trace of tuberculosis ; in Manchester, in cases where the disease is localised, the affected part is removed and destroyed, the remainder is passed. Numerous instances of similar discrepancy will be found in the evidence ; the above, taken almost at random, may be sufficient to illustrate the present condition of inspection applied to tuberculous carcases."

In the opinion of the Commission, effective and skilled meat inspection would not only be a safeguard to the public, it would often protect the meat salesman from unnecessary loss.

Thus they say :—

"Assuming that seizure of meat should be strictly confined to such as is dangerous to human health, we entertain no doubt that in certain places a great deal of meat is seized which is perfectly safe and wholesome food."

Public Slaughter-houses. — In reference to slaughter-houses, the difference between English and Scottish law is even more pronounced than in that of meat inspection. In England and Wales urban authorities may, if they think fit, provide public slaughter-houses, but they have no power to close private ones.

In Scotland the Public Health Act requires that all slaughter-houses shall be annually licensed.

On the objections to private slaughter-houses the Report reads :—

"So long as private slaughter-houses are permitted to exist, so long butchers, from use and wont, will continue to use them, and so long must inspection be carried on under conditions incompatible with efficiency, besides other disadvantages and risk to health which lie beyond the scope of our reference."

In concluding the review of this branch of the subject, the Commission say :—

Paragraph 32.—"We desire to add that, in some public slaughter-houses in the United Kingdom, serious physical

difficulties exist in the way of efficient inspection. The prevalent practice in the best continental abattoirs is to slaughter the animals in a common large, well-lighted, well-equipped hall. The inspector passes up and down, the offal is drawn out, close to the animal it belongs to, and exposed in full view. But in this country each butcher usually slaughters in a separate chamber, often extremely ill-lighted, and in some instances the offal of several animals may be seen thrown in a heap, so that it is impossible to distinguish the parts of one animal from those of others."

Compensation to Owners of Condemned Carcases.—After careful consideration of the subject, the Commissioners decided that they could not, on the merits of the case, recommend compensation for condemned carcases.

On the question of insurance against this risk they say:—

Paragraph 35.—"We received evidence as to systems of mutual insurance, under which the losses which are incurred by butchers by reason of the seizure of carcases of animals which before slaughter appeared to be healthy, have been met in different parts of the country, the ultimate cost of such insurance varying generally from a few pence to about one shilling per beast slaughtered. But the risk involved was not deemed by some butchers to be worth even this trifling expenditure. Other witnesses engaged in the meat trade expressed themselves as altogether opposed to the system of insurance, but in this connection it must be remembered, as one important and representative witness admitted, that recognition of the insurance system would practically do away with the plea for compensation. We believe that all losses by reason of seizure owing to tuberculosis of the carcases of animals for which a reasonable price has been paid can be best and easily met by the system of mutual insurance; and, with a view of promoting the use of public slaughter-houses, we are further of opinion that there would be advantage in districts where such establishments have been provided and are supervised by local authorities, in those bodies being empowered to contribute to the insurance funds."

That the local authorities should be empowered to contribute to the insurance funds seems a fair and reasonable proposition. The amount required

would obviously not be large, and the principle that unforeseen losses thrown on individuals in the interests of public health should at least be partially provided against by the public themselves, is an equitable one.

MILK SUPPLY.

On the danger arising from tuberculous milk the First Royal Commission, as already pointed out, took most exhaustive evidence, and on this subject their Report reads: "No doubt the largest part of the tuberculosis which man obtains through his food is by means of milk containing tuberculous matter," and this opinion is endorsed by the Second Royal Commission.

The evidence adduced before the First Commission leading to this conclusion has been considered in Chapter IV., and this branch of the subject is of such wide interest and importance to everyone that, as we take exception to the recommendations of the Second Commission on this subject, it is necessary to quote some of the Report *in extenso*. The italics do not occur in the text.

It reads as follows:—

Paragraph 37.—"We have already explained how unsatisfactory is the system of meat inspection in this country; but as regards milk, in relation to tuberculosis, inspection is still more so; indeed, it may be said not to exist. Even local authorities, who exert themselves to prevent the sale of tuberculous meat, are without sufficient powers to prevent the sale within their districts of milk drawn from diseased cows. It is true that in this respect the City of Glasgow possesses exceptional powers. Nevertheless, during the visit of some of your Majesty's Commissioners to that city they were shown in the public slaughter-house the carcase of a well-nourished cow which had been seized for generalised tuberculosis. She had been yielding milk to the day of her slaughter, as shown by the milk flowing freely from her udder, and might have continued to do so had not her owner sold her to the butcher."

Paragraph 38.—"It has been proved to our satisfaction from the returns of medical officers of health and meat inspectors that tuberculosis prevails to a larger extent among dairy stock than in any other class of animal. Considerable difference of opinion exists among experts as to the extent to which a cow may be affected with tuberculosis without rendering her milk dangerous. It was not proved to our satisfaction that tubercle bacilli had ever been detected in milk, unless drawn from a cow with tuberculosis of the mammary gland. In that case the disease generally, *but not always*, manifests itself by external signs, and the udder is suspected to be tuberculous. It is obvious, we think, that milk drawn from such a source ought to render him who exposes it for sale liable to heavy penalties. But there is no power at present to prevent such milk being sold. Professor McFadyean told us that, in a sample of milk from a diseased udder submitted to him for diagnosis, he had no difficulty in detecting tubercle bacilli, yet the milk from that cow continued to be sent in for sale in a neighbouring city. Unfortunately, tuberculosis of the udder can rarely be differentiated from other forms of udder disease by the ordinary stock owner or dairyman, and hence all udder diseases should be forthwith notified to the local authority."

Paragraph 39.—"The legislation in England and Scotland in the matter of milk does not show the same differences as have been noted in the case of meat.

"In both countries the *Dairies, Cowsheds, and Milkshops Order*, 1885, as amended in 1886, is the chief measure whereby local authorities can take steps to safeguard the purity of the milk supply. The Order contains very drastic sections, which, if thoroughly carried out by the local authorities, ought to go far to render satisfactory the housing of animals in cowsheds, and to protect the consumer from the danger of milk infected, through human agency, with such diseases as *scarlet fever*, or *diphtheria*. But from the evidence which we received, the Order would seem in some places to be a dead letter, and in the districts where it is enforced no attempt is made to obtain uniformity of practice."

"The Order empowers the local authority to make regulations, amongst other things, (*a*) for the inspection of cattle in dairies; (*b*) for prescribing and regulating the lighting, ventilation, cleansing, drainage, and water supply of dairies and cowsheds in the occupation of persons following the trade of cowkeepers and dairymen; (*c*) for prescribing precautions to be taken by purveyors of milk and persons selling milk by

retail against infection or contamination. Section 15 [of the Act] further states if at any time disease exists among the cattle in a dairy, or cowshed, or other building, or place, the milk of a diseased cow therein (*a*) shall not be mixed with other milk, and (*b*) shall not be sold or used for human food."

"But the term 'disease' in the Order is strictly limited to those diseases included under the *Contagious Diseases (Animals) Act*, 1878, *of which tuberculosis is not one*. The evidence abundantly shows how this fact has precluded local authorities from any attempt to deal with tuberculosis in milch cows, although they may have shown themselves alive to the danger, and anxious to provide a remedy.

"The suggestion has been made that the term 'disease' should be extended by the Local Government Board, under which Department the administration of the Order falls, so as to include tuberculosis, and we have received representations from various bodies recommending this, or at least that the term should be made to include tuberculosis in the udder. While your Commissioners think that it is desirable that the Order should be made applicable to all diseases of the udder in cows of which the milk is offered for sale, we are of opinion that it would be best for this to be effected without a change in the nomenclature of the Diseases of Animals Act, an Act which is concerned solely with the spread of disease from *animal to animal*, and not from *animal to man*."

It will thus be seen that as far as preventing the sale of tuberculous milk is concerned, both the Dairies, Cowsheds, and Milkshops Order, 1885, and the Contagious Diseases (Animals) Act, 1878, are dead letters. There remains the Infectious Disease (Prevention) Act, 1890, which "has been found, however, to be quite inapplicable to the purposes of tuberculosis or of udder disease generally in the milch cow."

Thus for practical purposes these Acts, framed in the interests of public health, are about as effectual in protecting the public against the sale of virulent milk from a tuberculous cow as are the shields of Zulu warriors against the bullets from a Maxim gun.

Glasgow has its own local Act, and under it the Police Commissioners, as mentioned above, "have

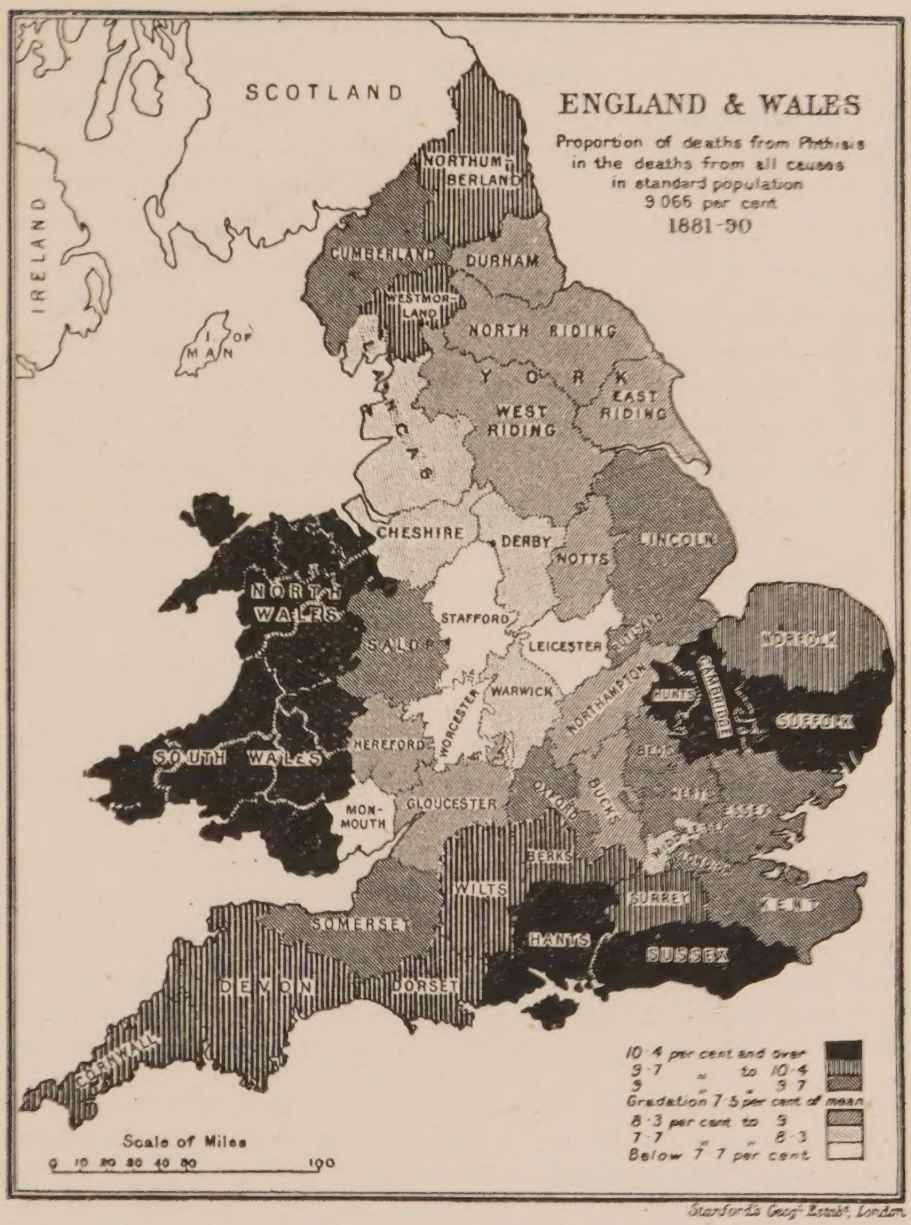


Fig. 11.—Reproduced by permission of Sir Hugh Beevor. From his Harveian oration on "The Declension of Phthisis." *Lancet*, April 15, 1899.

power to inspect all cows kept for supplying milk within their jurisdiction, and to proceed against the owner if he retains any cow which 'suffers from

tuberculosis or any disease' which might render the use of such milk 'dangerous or injurious to health.' Dr. Chalmers, one of the medical officers of health in Glasgow, holds that the use of the tuberculin test would be authorised by the powers of examination conferred under this Act, but it has not yet been employed without the consent of the owner. Only those animals visibly affected have been slaughtered, to the number of twenty-three in 1892 and six in 1896. The same powers of inspection are extended to all byres outside the city, whence milk is brought for sale within the city; but there are obvious difficulties in the way of exercising them, and, in fact, they have not yet been put in force."

One of the chief duties of the Second Tuberculosis Commission being to consider administrative procedure for controlling the danger to man through the use of the milk of tuberculous animals, it is necessary to review the conclusion they came to on this question in order to better appreciate their recommendations.

Referring to the first Report they say:—

Paragraph 42.—"We would recall the opinion quoted in their report by the Commission on Tuberculosis, 1894, to the effect that 'the spread of tubercle in the udder' is apt to proceed with rapidity, that it may be manifested and become distinctly developed 'between fortnightly inspections carried on along with a veterinary surgeon,' 'and that the very absence of any definite sign in the earlier stage is one of the greatest dangers of this condition.' And having regard to those circumstances, the Commission also report that both Dr. Martin and Dr. Woodhead, who carried out the experimental researches in this matter, 'insist that no tuberculous animal of any kind should be allowed to remain in a dairy.'

"We concur generally in the views expressed, but having regard to the extent to which tuberculosis exists among milch-cows, and to the absence of evidence that danger of conveying tuberculosis arises from the use of milk as a food apart from the existence of tubercular disease of the udder, we are of opinion that direct action for the elimination of all tuberculous

cows from dairies should proceed tentatively. There are, however, directions in which actions should be taken at once. These are : (1) systematic inspection of the cows in dairies and cowsheds by the officers of the local sanitary authorities within whose district the premises are situated ; (2) inspection, when desired, of the cows in any dairy or cowshed, wherever situated, by the authorised officers of local authorities within whose districts milk from the premises in question is supplied, on lines somewhat similar to those of sections 24-27 of the Glasgow Police (Amendment) Act, and of those embodied in the Infectious Disease (Prevention) Act, 1890, and the Public Health (Scotland) Act, 1897 ; (3) power for a medical officer of health to suspend the supply of milk from any suspected cow for a limited period pending veterinary inspection ; (4) power to prohibit the sale of milk from any cow certified by a veterinary surgeon to be suffering from such disease of the udder as in his opinion renders the animal unfit for the supply of milk, or exhibiting clinical symptoms of tuberculosis ; (5) the provision of a penalty for supplying milk for sale from any cow having obvious udder disease, without the possession by the owner of a certificate to the effect that such disease is not tubercular."

Comment on the inconclusive character of Paragraph 42 is reserved till the recommendations of the Commission come to be considered.

As showing the anomaly of the present state of the law, and the dangers which such law, or rather absence of law, entails upon the community, an experience that Sir George Brown, the veterinary adviser to the Local Government Board, relates, deserves recording.

Being anxious to make a pathological examination of a cow in an advanced stage of tuberculous disease, he arranged with an owner for the purchase of a carcase of such a beast, which the owner informed Sir George he was shortly going to destroy. As some time elapsed and the carcase did not arrive, Sir George sent round to inquire after his pathological specimen. The owner sent back word to say that he had changed his mind about destroying the cow, because he found that she ate so little and yielded

so much milk (*for sale*), that it would pay him better to keep her alive!

Since this time, however, as already indicated, a provision against wittingly selling tuberculous milk has been made in the Order of 1899 referred to (p. 131), but that it is, in the opinion of the writer, entirely inadequate in the absence of the tuberculin test among all dairy stock will be apparent from what follows.

THE ELIMINATION OF BOVINE TUBERCULOSIS.

The Commission recognise this to be the most important part of their inquiry. The Report reads:—

Paragraph 48.—"All precautions against the communication of tubercular disease to human beings by the consumption of the meat, or milk, of diseased animals must be regarded as temporary and uncertain palliatives, so long as no systematic attempt is made to reduce the prevalence of the disease among the animals themselves. We consider that by far the most important part of the inquiry committed to us, as to 'what administrative procedures are available and would be desirable for controlling the danger to man through the use as food of the meat and milk of tuberculous animals,' lies in the direction of eliminating the disease. To this part of the subject, therefore, we have directed most careful attention, and have used every means at our disposal of ascertaining the experience of foreign Governments.

Paragraph 49.—"We agree with the Committee of the Central and Associated Chambers of Agriculture, 'that any proposal for stamping out tuberculosis by means of slaughter, on the lines adopted with marked success in the case of cattle plague, foot-and-mouth disease, and pleuro-pneumonia, is quite impracticable.' Such an attempt, coupled with partial compensation to owners, was initiated by the Belgian Government in 1895, but, as will be seen from the Report of the Commissioners who visited that country in the spring of 1897, it was found impracticable, and the cost of it intolerable."

Isolation, not Destruction.—The Report then goes on to quote at length the attempt to grapple

with and eliminate the disease undertaken by the Danish Government, based on the value of tuberculin, and the services of a veterinary surgeon free of charge to all owners willing to avail themselves of these opportunities for testing their stock, provided they undertook to separate by a partition the healthy from the tuberculous portion of the herd.

The results of these experiments were satisfactory to farmers and Government alike, and are given in a tabulated form in the Report. At the end of the Report are the recommendations of the Royal Commission, and as they are presumably likely to form the basis of future legislative action, they are given in full in the Appendix. These recommendations we must now consider.

With regard to meat, meat inspectors and their duties, cowsheds and their requirements, the recommendations of the Royal Commission, if acted on, would appear to meet the requirements of the case. And if the destruction of tuberculous beasts really be impracticable, on the ground of the great outlay involved, it must also be admitted that the measures suggested for the elimination of tuberculosis are worthy of every consideration. For if these measures do not hold out the prospect of at once accomplishing their object, they at least are in the right direction, and must diminish the amount of tuberculosis among cattle by checking its spread. It is from the tuberculous cattle that healthy beasts become infected, and if the tuberculous cannot be actually destroyed, they can and should be isolated, as the one other means of minimising the spread of infection amongst sound cattle.

So far, then, the recommendations of the Commission are likely to be productive of nothing but good, if acted upon, and the health both of men and beasts improved and protected by their adoption.

But when the recommendations for dealing with the tuberculous milch cow come to be considered, it must be confessed that they appear to the writer to fall lamentably short of what common honesty and public safety alike demand. It must be borne in mind that both the Commissions are agreed that "the largest part of the tuberculosis which man obtains through his food, is by means of milk containing tuberculous matter."

They are further agreed that tuberculosis is rife among milk cows, and that dairymen can, and do, sell virulent milk, containing tubercle bacilli, with absolute impunity.

The high and increasing mortality from tabes mesenterica, in infants under one year of age, is admitted by Sir R. Thorne * —himself a member of the Second Commission—and further by Sir William Broadbent,† to be clearly due to the consumption of such virulent milk. In the face of this, it is insufficient to urge that if milk be boiled all danger will be averted.

The public who buy milk do so in the belief that they are buying a pure article, fit for human consumption. The dairyman who sells milk is morally, and should be legally, bound to take precautions to see that his milk is pure, and where he fails to do so should be liable to penalty.

What, then, do the recommendations of the Second Commission amount to? They recommend that "notification of every disease in the udder shall be made compulsory," and they further recommend that local authorities shall be granted powers to slaughter "such cows affected with tuberculosis of the udder, or exhibiting clinical symptoms of the disease." But why such a half-measure to combat and prevent "the

* "Harben Lectures," 1898.

† Speech at Marlborough House, Dec., 1898.

largest part of the tuberculosis which man obtains through his food" ?

That the step recommended is but a half-measure is clearly established by both Reports. Thus, in the First Commission's Report the following paragraphs occur :—

Paragraph 62.—"And not only this virulence, but the rapidity with which milk can obtain its harmful quality, attracted Dr. Woodhead's attention. He reports : 'A most important point is that the spread of tubercle in the udder goes on with most alarming rapidity ; this I was able to observe in the cows constantly under observation, but I have also noticed on several occasions during the interval between fortnightly inspections carried on, along with a veterinary surgeon, that the disease has become distinctly developed. It may be, of course, that the early evidence has been overlooked at the previous inspection, but whether this is the case or not, the spread of the disease was so rapid as to afford very good ground for alarm. The very absence of any definite sign in the earlier stage is one of the greatest dangers of this condition.'" (Section 104, p. 143.)

And both Dr. Martin and Dr. Woodhead insist that no tuberculous animal of any kind should be allowed to remain in a dairy.

Paragraph 63.—"The withdrawal from dairies of every cow that had any disease whatever of her udder would form some approach to security against the serious danger incurred by man from the use of tuberculous milk, but it would not be an adequate security. The presence in a dairy of a tuberculous cow, as Drs. Martin and Woodhead have shown, is a decided source of danger to the public, especially having regard to what we have learnt respecting the rapid development of tuberculosis in the udder, and the degree of danger to milk consumers incurred by the invasion of the udder in tuberculous cows."

As, however, the members of the Second Commission were in no way bound by the conclusions arrived at by the First Commission, it is necessary to consider their own recorded views on this subject. Turning to the Second Commission's Report, in Para-

graph 38 the following occurs: "It was not proved to our satisfaction that tubercle bacilli had ever been detected in milk, unless drawn from a cow with tuberculosis of the mammary gland. In that case the disease generally, *but not always,* manifests itself by external signs, and the udder is suspected to be tuberculous."

Again, on the difficulty of recognising "clinical symptoms" of tuberculosis in cattle the expert veterinary evidence of Professor McFadyean is taken and embodied in the Second Commission's Report. It occurs in Paragraph 13 of the Report, and reads as follows: "No person, whether he were a layman or a veterinary surgeon, when summoned to look at an animal suspected of showing symptoms of tuberculosis, could give an opinion that was really of much value in the great majority of cases *unless he used tuberculin.*"

How, in the face of these views, which the Commissioners frankly avow in their own Report, they could arrive at so inconclusive, illogical, and imperfect a measure as "notification of udder disease" and the destruction of cows so affected, as the sole remedy to be recommended against the "largest part of the tuberculosis which man obtains through his food," it is difficult to comprehend.

The one obvious remedy indicated by their own Report is the periodical application of the tuberculin test to all milch cows, and the *exclusion*—not necessarily the destruction—of all tuberculous cows from that portion of the herd from which the public milk supply is derived. Why have they not recommended this measure? On their own showing, "tuberculosis of the mammary gland"—udder disease—*does not always* manifest external signs, and where there are none, it is obvious the affected cow will neither be notified nor destroyed, but will go on producing milk

for the consumer's use. While as to the "clinical symptoms of tuberculosis," the one other disqualification for the milch cow, we again have the Commissioners' own assurance that from these symptoms no reliable opinion can be given even by a veterinary surgeon—"unless he used tuberculin."

One is therefore compelled to suppose, by the Commissioners' own Report, that the application of the tuberculin test to all milch cows, and the removal of tuberculous stock from the dairy—the only reliable measure of protection—would be, in the opinion of the Commissioners, too costly a procedure. Yet they do not hesitate to recommend it to stock-breeders as a means of eliminating tuberculosis among their stock; and they do so, not merely on grounds of public health, but adduce evidence which suggests that the measure will also be to the eventual commercial advantage of stockowners themselves. Surely, what may be commended for the benefit of the beast and the ultimate profit of the owner might fairly be insisted on for the protection of human health "against the largest part of the tuberculosis which man obtains through his food." That there should be one measure in the interest of the beast and his owner and another in the interest of the public is, on the face of it, not unnatural, but that the difference should be entirely in favour of owner and beast does not seem equitable.

The effect of isolating all milch cows reacting to tuberculin would, no doubt, be at first to considerably diminish the number of cows available for milk purposes, and as a serious economic problem would arise, the question of what might be done with the milk of reacting cows requires consideration.

Milk from reacting Cows.—The cow with a tuberculous udder should in any case be destroyed —on that the Commission is agreed but the milk

from reacting, or practically from tuberculous cows not manifesting external evidence of udder disease, would simply be milk open to suspicion; it would, in fact, be milk which, if the too modest recommendations of the Commission on this subject are adopted, will still be freely sold to the public as healthy food. If, therefore, this milk were boiled at the dairy, it might both be sold for human consumption, due notification of the fact being given to the authorities, and it might be used for the feeding of calves and pigs. The whole subject of tuberculosis is now receiving attention both in the United States and in British colonies. Colonists are practical men, and South Australia has passed an Act which provides that milk from cows reacting to the tuberculin test in any stage of the disease may not be sold, unless boiled for ten minutes, and notification to that effect made to the Local Board. This is a logical, practical, and wise provision, and should be adopted in England. Governments of young countries have less difficulty in passing an Act of domestic legislation than older ones; but we have taken from Australia the principle of the Ballot Act, and we cannot do better than follow her example in this case.

The dangers to human health arising from tuberculous food are thus seen to be subject to measures of administrative control, although their application in England has yet to be accomplished.

NOTIFICATION OF PHTHISIS.

The danger to the community from tuberculosis in man cannot so readily be controlled by legislation. Applications have several times been made by different local authorities to the Local Government Board to have, in some instances phthisis, in others tuberculosis, scheduled as infectious diseases under

the "Infectious Diseases Act." These applications have not hitherto been granted.

To bring phthisis under the Infectious Diseases (Notification) Act of 1889 would be to bring into force against it a series of regulations which are especially intended for acute infectious diseases, and not for a chronic disease such as phthisis, the course of which may extend over a number of years, and which, although communicable, is so through more indirect channels than is the case with the acute infectious diseases.

The practical measures which should be taken with the phthisical subject are:—

To provide each one with a leaflet of simple instructions as to the disposal of the sputa, and other precautions necessary to prevent the spread of tuberculosis.*

To encourage the voluntary isolation of all consumptives in suitable sanatoria.

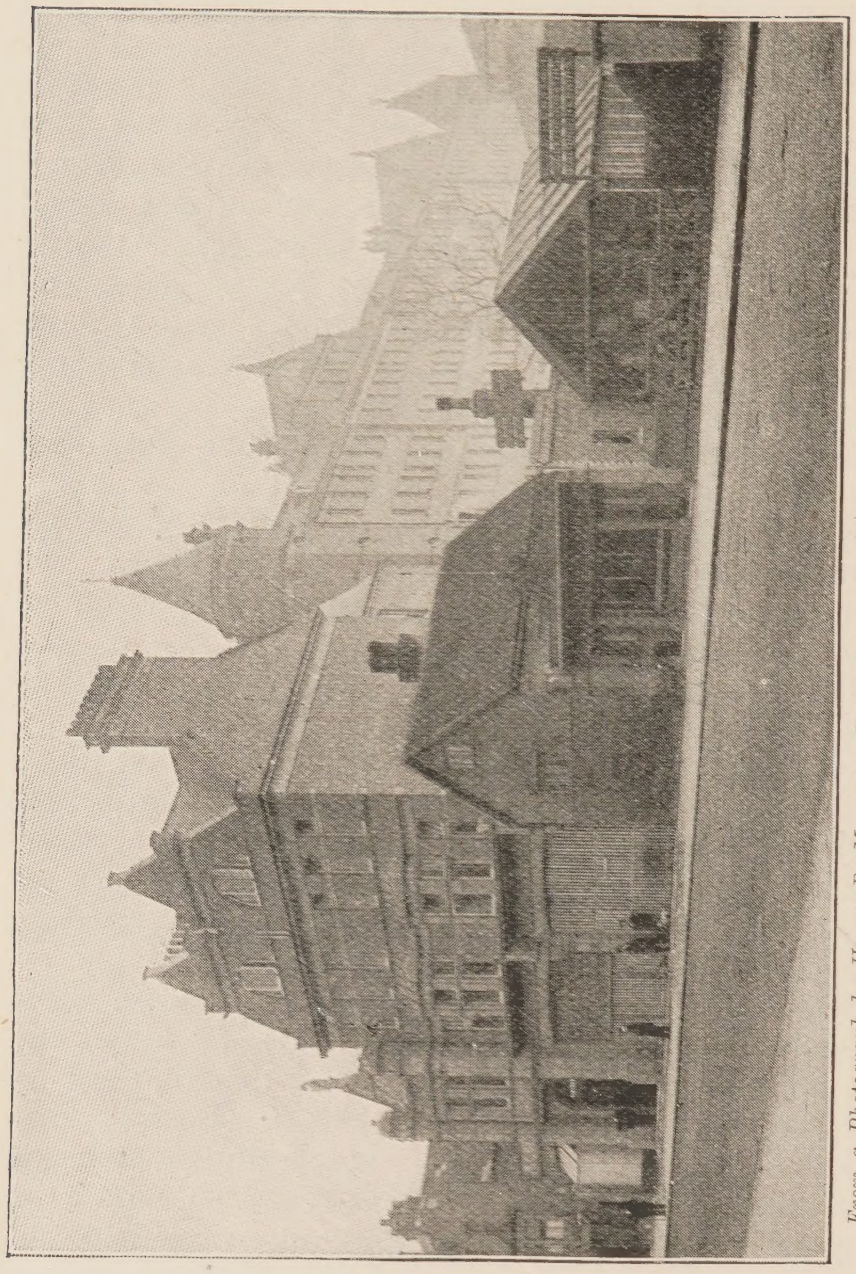
To thoroughly disinfect after death the room, bedding, etc., which have been used by consumptives.

The provision of printed instructions, if necessary at the public cost, might be made compulsory on all public institutions and medical men treating phthisical patients.

The encouragement to voluntary isolation must be left to medical men and the friends of the patient. The measures of disinfection could be carried out by local sanitary authorities if, as Sir R. Thorne † suggests, "deaths from phthisis were included amongst those deaths from infectious diseases of which so many sanitary authorities now obtain immediate information from the Registrar of Deaths for a trivial payment of 2d. an entry." There would be very little chance of arousing opposition to this step on the part

* Appendix, Leaflet No. 1 (p. 226).

† Harben Lectures, 1898.



From a Photograph by Harry B. Measures, Esq.

Fig. 12.—Rowton House, Hammersmith Road, W.

of the public if discretion were left to the medical man, where one was in regular attendance, to supervise these measures; and if, where the authorities

directly carried out the necessary steps, the process of compulsory "renovation" on the part of the owner, described by Dr. Herman Biggs as being in use in New York, were combined with disinfection. Renovation consists in the application of simple and inexpensive measures, "i.e., scrubbing painted woodwork and floors with a hot soda solution, and re-painting, re-papering, or re-kalsomining the walls. These measures are certainly efficient in ridding an apartment of tubercular infection (while efficient disinfection in such apartments is difficult or impossible), and at the same time they are easily understood, leave the premises in an improved condition, and as a consequence are cheerfully acquiesced in by the tenants, and are promptly carried out without objection in almost every instance by the owners of the buildings."

The consumptive has not yet been recognised in England as a source of danger to the community, and whatever action may eventually be considered necessary must be undertaken with every regard to the feelings of the sufferer and his friends. As the sufferer and his friends are those chiefly benefited by rational precautions, there should be no difficulty on the part of medical men in inducing them to adopt measures beneficial both to themselves and the public.

The Report of a French Commission appointed to consider the notification of Phthisis was to the effect that for the present "it must not be dreamt of." The same Report contains the following reference, which shows the extreme importance of observing necessary precautions with regard to the destruction of phthisical sputa in the minds of Norwegian physicians;—Drs. Holmboe and Nanssen, charged to prepare for Norway a scheme of legal action against tuberculosis, recommended that where the consumptive either cannot, or will not, take the necessary

precautions for the destruction of tuberculous sputa, "he should be compulsorily detained in a hospital."

There is a certain Norse rigour about this recommendation which we hesitate to endorse. At the same time, as public opinion becomes educated as to the true nature of tuberculosis, it is quite probable that notification and supervision of cases will be insisted on, and we confess that, if public health be a legitimate subject for public legislation, it seems to us theoretically they should be. Objectors to notification ask, "When you have notified a man what are you going to do with him?" The authorities could then, at least, see that he has medical attendance in some form, and that he receives specific instructions as to the precautions necessary for his own and the public safety. Further than that, as Dr. Newsholme,* the medical officer of health for Brighton, has pointed out, notification of phthisis will "enable centres of insanitation and infected areas to be localised," and such localisation would be of inestimable value as a further guide to the authorities in whose hands lies the administration of the Housing of the Working Classes Act. Dr. Philip, of Edinburgh, says: "I remain firmly of opinion that such notification is the only sound and logical solution of the tuberculosis problem." †

An alternative method, and one that has already found favour in some communities, is, perhaps, in the meantime more expedient. It is that of voluntary notification.

In advocating this policy at the Sanitary Congress, 1899, Mr. Malcolm Morris dwelt on the assistance in this direction which lay visitors might give by

* *Brit. Med. Journal.* Discussion Section of State Medicine. September 2nd, 1899.

† Health Lectures for the People. No. 4. Published by the Edinburgh Health Society.

encouraging patients to report themselves to the authorities. The whole question is one of vital importance, but hitherto the National Association for the Prevention of Tuberculosis has not gone beyond recommending voluntary notification. Legislators have not yet forgotten the difficulties in late years of dealing with vaccination. For in these matters, unfortunately, the Government is guided not by experts but by the free and independent elector.

* * * * *

Food obtained from tuberculous animals, and the sputum of the consumptive, are then the chief sources from which tuberculosis is derived, and both are amenable to control. In addition, there are conditions which favour the establishment and development of the disease in man which are and should be made the subject of legislation. The atmospheric impurities associated with certain occupations, as the metallic dust created in metal works, the organic dust in the manufacture of textile fabrics, and the respiratory impurity—most deadly of all—which arises in crowded factories and workshops, and in crowded, small, ill-ventilated dwellings, all strongly favour the development and spread of tuberculosis.

These evils have already been referred to (p. 122), and the recognition of their deleterious influence has called both the Factory Acts and the Housing of the Working Classes Act into existence.

The Factory Acts deal with the limitation of the hours of work, regulations of hours for meals, and the removal of gases, vapours, dust, etc., generated in the various processes of manufacture; they also regulate the cubic space allotted to each worker.

The Housing of the Working Classes Act gives power to Local Authorities to deal with "individual

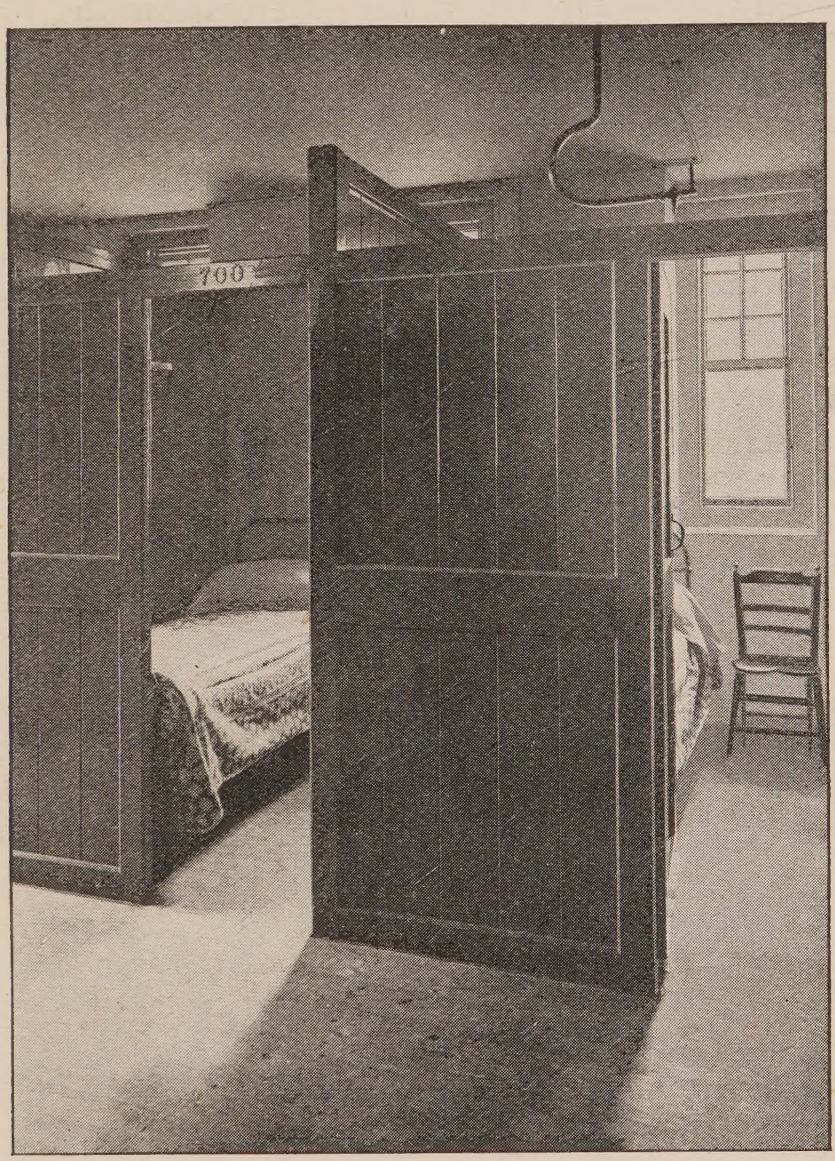
houses, or any collection of houses, courts or alleys, which could be regarded as unfit for human habitation, either by reason of a deficiency of light, air, or ventilation, or because of the narrowness, closeness or bad arrangement, or bad condition, of the streets and houses."* How far these measures really combat the evils for the prevention of which they exist, is for our public officers of health to determine. In London, at all events, I am able from personal observation to testify that the overcrowding, though still in many quarters deplorable, is nowhere so great as in many doss-houses and other *asiles de nuit* still existing in the older quarters of Paris.

Rowton Houses.—Fortunately, the solution of this problem in England has been largely assisted by philanthropy and private effort, and the name of Lord Rowton will ever be honourably associated and remembered in connection with one of the most important social movements of the present generation. The various Rowton Houses — large model lodging-houses erected in different parts of London—are too well known to need more than a passing reference here. In them have been combined the advantages of co-operation on a large scale, and some considerable measure of the comfort of a modern club. Cleanliness, air, light, and economy have taken the place of squalor, filth, and waste. The cost for each individual is only a trifle more than is paid in the lowest city lodging-house, and the gain to physical—to say nothing of moral—welfare is invaluable. Moreover, commercially these lodging-houses are a success. (Figs. 12 and 13.)

They, therefore, have an assured future, and already many cities are providing similar establishments for the poorer classes. If they have not hitherto been made to meet the requirements of

* Dr. Kerr Chalmers, *Practitioner*, June, 1898.

married life among the masses—a development we may yet hope to see—they will at least prevent



From Photo. by Harry B. Measures, Esq., architect of the building.

Fig. 13.—Two Cubicles, in Rowton House, Hammersmith Road, W.

in the future the erection of narrow, pestilent doss-houses, so long a disgrace to London, and which

still remain hotbeds for all forms of microbic disease in nearly every other capital in Europe. Our illustration is taken from the Hammersmith Road establishment. It remains to be stated that in this admirably planned building each cubicle has one bed and a window of its own.

The Airing of Cities.—The great value of parks, gardens, and open spaces must be remembered in all cities. Municipal authorities are gradually waking up to the importance of giving "lungs" to our huge towns, and in the future it is to be hoped that less crowding and the abolition of narrow streets will be insisted on. Further than this the people, especially the delicate among them, should be more freely encouraged to use what public spaces we have. The gardens and parks already in existence might well be more liberally provided with comfortable and protected seats.

CHAPTER VII.

TREATMENT OF TUBERCULOSIS.

Spontaneous Healing of Tubercular Foci—Caseation *v.* Sclerosis—Open-Air Treatment—Tuberculosis an Indoor Disease—Evidence from the Animal Kingdom—Absence of Catarrh in Open Air—The Action of Pure Air on the Consumptive—The Toxic Qualities of Respired Air—Observations of Paul Bert, Brown-Séquard, D'Arsonval, and Others—The Toxic Respiratory Impurity an Effete Animal Product on which, when re-absorbed into the Tissues, the Vegetable Tubercle Bacillus Flourishes—Wind, Rain, and Fog—Ventilation and Draughts—Temperature of Rooms—Ocean Voyages a Lottery—The Stuffy Cabin—High Phthisis Rate in French Navy and English Training Ships—High Altitudes—Dry Climates—Veld Life—Kimberley Sanatorium—Sanatoria for the Treatment of Consumption—Görbersdorf—Folkenstein—Nordrach, and the Nordrach *Régime*—The Grabowsee—Portable Huts—British Sanatoria—Results at Different Sanatoria—In Germany—In Great Britain—Requirements of a Sanatorium—London Open-Air Sanatorium—Principles of Treatment in a Sanatorium—Daily Routine—Walking Exercise—Febrile Cases—Pocket Spittoons—Open Air Treatment in Private House—Cases of Tuberculosis in General and Special Hospitals—Treatment of Special Symptoms: Fever, Hæmoptysis, Pain in Tubercular Meningitis—Sweating—Cough—Dyspepsia—Diarrhœa—Specific Treatment—Tuberculin, T. O. and T. R.—Surgical Treatment.

In discussing the treatment of various forms of tuberculosis, the first thing to be borne in mind and considered is the spontaneous healing of many tubercular lesions which careful post-mortem and pathological investigation has clearly demonstrated to occur. The very fact that these cases of spontaneous healing do occur, sometimes in cases where the presence of tuberculosis had not even been suspected, is sufficient evidence that conditions may arise or be induced within the host, or patient suffering from tuberculosis, which will check the course of, and in some cases entirely eliminate, the disease.

Laennec was one of the first to maintain the curability of phthisis. Koch in his famous essay refers to it, and specially cites cases where tubercular foci which had reached a fair size have subsequently contracted, cicatrised, and healed up. Vibert published in Paris recently statistics showing that out of 131 autopsies made at the Morgue on persons who had met with violent deaths, 17 had healed tubercular lesions. Loomis gives an account of 763 autopsies made in New York on subjects who had died from affections other than pulmonary tuberculosis, in which 71 had healed tubercular lesions. Other similar statistics have been published.* Evidence that spontaneous cure does occur is, therefore, abundant, and what the physician has to determine is what are the conditions and line of treatment which go to establish that state in the host which is fatal to the tubercle bacillus. As Osler says: "In all tubercles two processes go on, the one caseation, destructive and dangerous, and the other sclerosis, conservative and healing. The ultimate result in a given case depends upon the capabilities of the body to restrict and limit the growth of the bacilli."

To produce and strengthen these capabilities must be the aim of curative treatment. Some writers divide treatment of tuberculosis into general hygienic measures, specific treatment, and treatment of symptoms; but the term hygienic measures is so vague, and the lines of rational treatment indicated are to my mind so clear and definite, that I have adopted in preference a more distinctive title, and shall consider treatment under the three headings—

Open-Air Treatment—most valuable of all.

Treatment of Special Symptoms.

* At the Annual Meeting of the Brit. Med. Assoc. at Portsmouth in 1899, Prof. Clifford Allbutt gave statistics of post-mortem results at Leipzig, where the proportion of old tubercular lesions was higher still.

Specific Treatment—which will include a brief review of the researches as to tuberculin and serum, but which is not at present of practical use.

OPEN-AIR TREATMENT.

The principles which this mode of treatment recognises as of paramount importance are not entirely expressed in the descriptive term chosen, but the term at least has this advantage over "general measures," "hygiene," or any other that can well be used. It conveys in an unmistakable manner what is the vital and absolutely essential condition required, without which everything else is as naught. For the cure, as well as for the prevention, of tuberculosis, first and foremost, transcending all other measures, as the sky transcends the loftiest habitation, comes pure air. Accompanying this, and in a large measure the result of this, are abundant feeding (rendered possible by the robust appetite which fresh air engenders) and repose, that plentiful, untroubled sleep and rest which the natural and simple animal life procures. It is the tissues of the animal man on which the tubercle bacillus preys and flourishes; it is the animal man which must be fortified against it. Departure from the natural animal life to the artificial indoor life of civilisation renders the introduction and establishment of tuberculosis a possible disaster. Return to the animal life best combats the effects of this disaster should it occur.

Before considering in its full application and detail all that this mode of treatment entails in the form of practical measures—measures which, to be effective and thorough, require that minute and careful instructions should be given to the consumptive and be acted on by him—it will be well to review such facts as have already been collected in relation to the

etiology of tuberculosis in animals and man, which unmistakably point to the necessity of this treatment, if the cure of a tuberculous condition sufficiently advanced to be clinically recognisable is to be obtained. Among the lower animals tuberculosis, as far as is known, is a rare thing under natural conditions. Thus Nocard* states that although both rabbits and guinea-pigs are excellent re-agents for the disease, and take it quickly and violently when inoculated, tuberculosis is very rarely found among them in a state of nature. What is of even more interest from the curative point of view is a series of experiments performed by Trudeau in America showing that rabbits inoculated with tuberculosis confined in a damp, dark place rapidly succumb, while others turned out to run wild recover or develop only slight lesions. Nocard also states that monkeys, giraffes, antelopes, llamas, gazelles, etc., in zoological gardens are decimated by the disease; and in regard to the incidence of the disease among animals in the Zoological Gardens in London, Sir Samuel Wilks† gave a remarkable illustration of the effect of open air. He said that the idea used to be to keep up a high temperature in the houses of certain animals from the tropics. "Now they let these animals go out even in winter into the fresh air, and the mortality is considerably less."

Among cattle, as was shown by the Report of the Royal Commissioners already referred to, it is among the closely confined milch cows that tuberculosis is principally found, whereas among the cows run in the open air in Jersey it scarcely exists. Even the abundant feeding of the stalled ox is not enough to protect him from the disease, and, as a matter of fact, he is far more liable to it than his fellow fed on a

* "The Animal Tuberculoses."

† Meeting at Marlborough House, Dec., 1898.

half-starvation diet over some barren moorland, but who is continuously in the open air. Among sheep, which are practically never housed, tuberculosis is rare.

From the animal world, then, the evidence as to the effect of open air in preventing, and also curing, tuberculosis is clear.

Among mankind, what are the conditions which principally determine the incidence of tuberculosis? Overcrowding, and an atmosphere contaminated with respiratory impurities, are, as has been shown, those most conducive to the successful establishment of the disease. As a preventive measure, the provision of the opposite of these conditions was discussed in Chapter V., and the rationale of their efficacy demonstrated.

With regard to the tubercle bacillus itself in relation to open air, it was also shown that the conditions most favourable to its continued existence and virulence outside the body were darkness, filth, damp and foul air; to its destruction, light—preferably sunshine—and pure air.

From this review of facts with reference to tuberculosis, established by careful bacteriological research and statistical compilation, it is perfectly obvious that the open-air treatment of tuberculosis, and all that it implies, is no mere empiricism. It is neither the passing nostrum of a fashionable physician nor one of a number of stock prescriptions in use at some public hospital. It is a recognition of certain truths in relation to the intimate pathology of the disease, and a practical expression in curative medicine of that recognition.

This form of treatment is generally associated with, and is most beneficial in, cases of pulmonary tuberculosis, especially those in the earlier stages, but it is also undoubtedly of value in other forms

of the disease, and may be undergone with the greatest advantage by scrofulous children. Of the singular effect which open air has upon the ordinary cold, or catarrh, I have myself had a striking experience. Several years ago it was my duty to proceed at short notice with a column of mounted troops sent to the relief of forces engaged on the Kaffir frontier—a forced march of several hundred miles. I had at the time a particularly aggravating catarrh, and remarked as we started to a veteran campaigner that I was afraid sleeping in the veld would not improve it. He laughed, and replied that sleeping out of doors a man never caught cold, and further, that he immediately lost any cold he might have, provided, he added, that the head was always kept warm. A woollen nightcap was part of our kit. In twenty-four hours a cold which had worried me for a fortnight, and which under ordinary circumstances would have remained with me for at least another fortnight, had totally disappeared. Months of camp and waggon life in the open air have convinced me that my veteran friend's statement about catarrh is absolutely true. My own experience in this respect is entirely borne out by that at different open-air sanatoria. Under ordinary circumstances, and with frequency in general hospitals, the consumptive is troubled with attacks of catarrh. At open-air sanatoria these attacks very seldom occur.

The Action of Pure Air on the Consumptive.—The beneficial and curative effect on the phthisical patient of this mode of treatment is now widely recognised, and the statistics from different open-air sanatoria which we shall have to consider abundantly testify to it. What, then, is more precisely the action which pure air has? It is true it is largely destructive to the life of the tubercle bacillus outside the

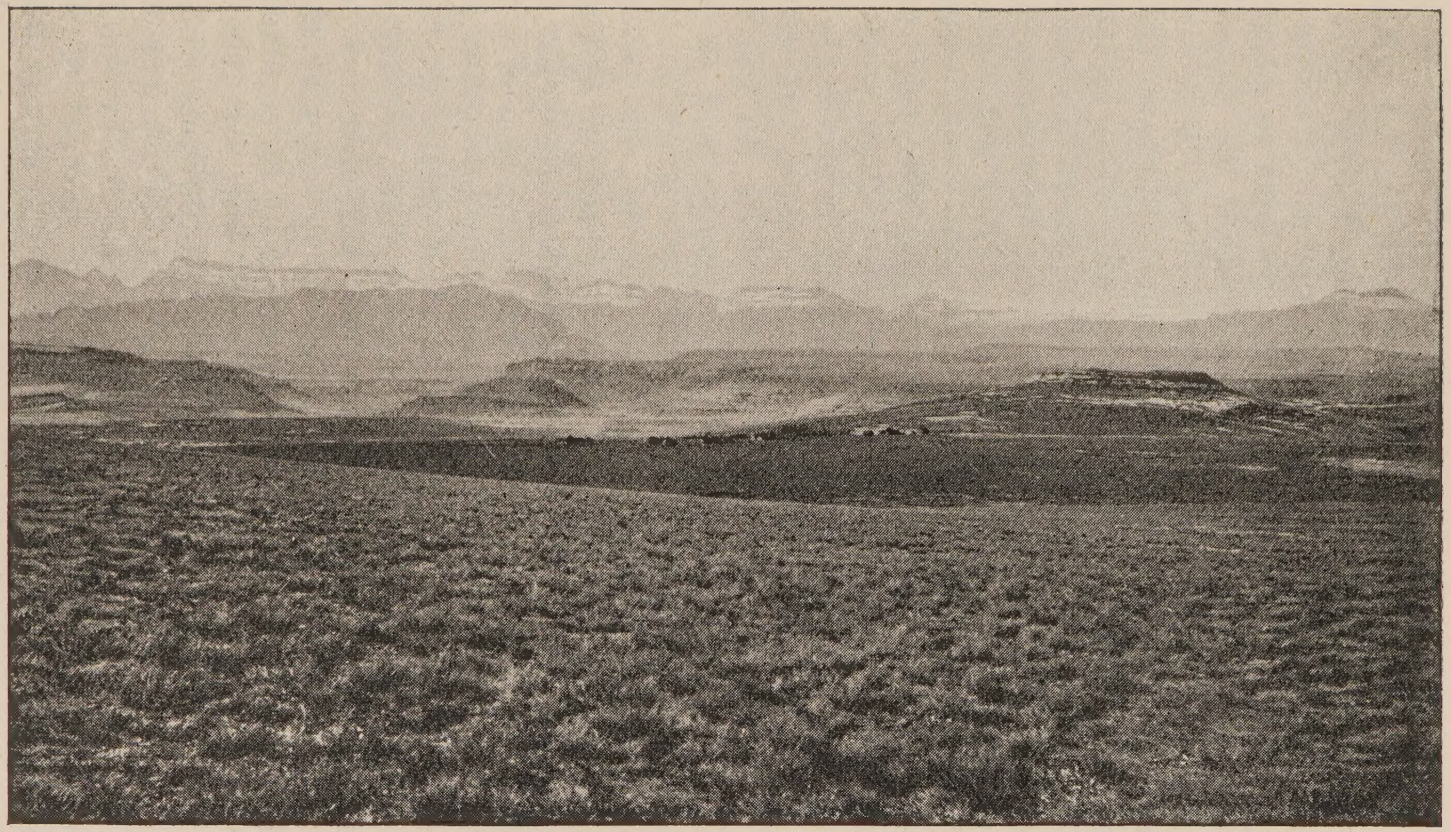


Fig. 14.—High Veld, at the foot of Maluti Mountains, Basutoland, South Africa.—Winter.

body, but can it be held to have any direct action on the tubercle bacillus when once buried within the tissues of the host? It is difficult to see how it could act directly in this way, nor am I aware of any evidence which could fairly be held to suggest that it does. By helping to destroy all tubercle bacilli with which the consumptive may be brought in contact outside the body, whether lodged there from his own sputum or from any other source, the risk of being invaded with fresh doses of virulent organisms is diminished by the pure air surrounding him, but on the bacilli actually within the tissues the action is indirect through the tissues themselves. The action is on the soil containing the seed, not directly on the seed itself, when once that seed is sown. But what is the action of pure air on that soil? In what way specifically are the tissues affected? At one time it was supposed that the diminution of oxygen and the increase of carbonic acid in an atmosphere vitiated by respiration were the elements most noxious in that atmosphere to the person breathing it. The experiments of recent investigators have, however, thrown considerable doubt on that explanation. As stated above, the action of pure air is directly on the tissues, and through them indirectly upon the microbe. Pure air cannot destroy the microbe buried in the tissues, but it can so intensify and invigorate the cellular elements of those tissues as to enable them to do so, and this it does not merely by its oxygen or by its comparative freedom from carbonic acid, but by virtue of its freedom from the organic impurities which the respired air contains, those impurities thrown off among other effete or waste products of combustion within the body through the channel of the expired breath. Provide the cells of the tissues with pure air, a normal requirement, and the fungus, the

tubercle bacillus, is either checked or destroyed in its growth upon them. But, on the other hand, as manure, an effete animal product, put into land causes the vegetable seed sown in it to flourish, so do these respiratory organic impurities (another form of manure) or effete animal product, re-inhaled into the lungs and re-absorbed by the tissues, cause the vegetable fungus tubercle bacillus to flourish. Someone has described breathed air, which is saturated with respiratory impurity, as containing air sewage. The term exactly describes the condition, and this sewage constantly bathing the soil or tissues of the consumptive causes the vegetable tubercle bacillus to grow and thrive in them. Cut off the supply—or, in other words, subject the patient to open-air treatment—and the bacillus is starved and checked in its growth.

This is scientific fact and not mere metaphor. Thus, Daremberg,* a French physician, and himself a sufferer from phthisis, cured by open-air treatment, has been at considerable pains in his interesting little book to explain the true character of the noxious qualities in respired air. He says the confined air of closed chambers is unhealthy, and it is desirable to know why it is injurious to the sick and especially to the phthisical. Is it, as was so long supposed, because it contains too little oxygen? Leblanc showed that the air of a lecture-room containing 1,000 cubic mètres of air and 1,000 persons had only lost during an hour 10 per cent. of oxygen. On the other hand, Paul Bert has shown that respirable air can lose without inconveniencing persons breathing it 15 per cent. of oxygen; thus the ill effect upon the phthisical subject of confined air is not due to the diminution of this gas. This observation of Paul Bert has recently received striking

* "Traitement de la Phtisie Pulmonaire."

confirmation in the experiments of Mosso,* an Italian physiologist, made with rarefied air at high altitudes. The next point for consideration is whether the accumulation of carbonic acid exhaled from the lungs during respiration has the noxious influence observed. The researches of Reiset have shown that the external air contains about 0·3 per 1,000 of carbonic acid. Oertel has found 0·8 per 1,000 of this gas in a brewery, and also in a lecture-hall.

But as Pettenkofer has been able to breathe without any ill effect, for an hour, an atmosphere containing 10 per thousand of carbonic acid, and as Brown-Séquard and d'Arsonval have breathed without being "incommoded" mixed gases containing 20 parts of carbonic acid to 60 parts of air, it is certain that the ill effect of bad air on the phthisical subject is not due to the accumulation of carbonic acid gas. Gavarret first contributed to the solution of this problem. He placed animals under a bell glass, and although he replaced the oxygen as soon as it was absorbed, and caused the carbonic acid to be absorbed as soon as it was produced, the animals died. Hammond, of New York, in repeating this experiment, showed that air rendered unbreathable in this manner, when forced through a solution of permanganate of potash, discoloured it, because it contained a large quantity of organic matter. Several German physiologists also saw that this asphyxiating air contains a notable quantity of organic substances.

Brown-Séquard and d'Arsonval at length went far to show that the toxic qualities of confined respired air are due to the expired vapour containing organic matter. They collected in a refrigerating apparatus the vapours contained in air expired by a man, and they injected the liquid thus collected under the skin

* "Life at High Altitudes."

of rabbits and guinea-pigs. Both rabbits and guinea-pigs succumbed to these injections. These experiments show that the lung exhales vapours charged with poison. The assimilation of food and the constant changes in the tissues fill the body with toxic substances. These are eliminated in the fæces, the urine, the sweat, and pulmonary exhalations. We do not reabsorb the poisons eliminated by the kidneys or the skin. "Why," asks Daremberg, "should we reabsorb poisons exhaled from the pulmonary surface by breathing an air already breathed?" I have already referred to the effete respiratory products which breathed air contains as furnishing material for the nourishment and growth of the vegetable bacillus within the tissues. There is another noxious quality of impure air. It is in impure air that the septic micrococci are most abundant. These are carried into the lungs and add their effects to those of the tubercular process.

No further evidence as to the scientific basis for the open-air treatment need be adduced, and I cannot do better than preface the direct consideration of this treatment by quoting the eloquent testimony of Daremberg, derived from his own personal experience.

"No one," he writes, "knows the happiness of the consumptive who quits his tainted chamber to live *au grand air* if he has not himself experienced the benefits of this change. In 1876, after having passed several months between the four walls of a small room in Paris, I arrived on the French Mediterranean coast, and, after the advice of Henri Bennet, I stretched myself out all day in the sun, at night I lay with my window open. . . . As Voltaire says, 'The hope of recovery is already half a recovery.' Soon my powers revived: I could walk, make small excursions, find pleasure in existence. I discovered that

the sun of my life had not yet set. I saw it rise each morning with delight, and each day linger too short a time to allow me to enjoy to the full the pure air, the bright light, the blue sea, the heavens, the earth —everything. It is good to feel oneself reborn."

"This life in pure air, night and day, stimulates the appetite, improves the digestion, suppresses the fits of coughing, facilitates expectoration and the respiratory movements, invites calm sleep. And when the consumptive has an access of evening temperature, that access passes almost unperceived by him. . . . Generally both fever and sweats gradually disappear."

It is now necessary to consider what is embraced by the open-air treatment. The first object being the purest air obtainable, it is obvious that the more the patient can live in the open air the better, and accordingly the consumptive should so regulate his life as to spend it almost entirely out of doors, and when indoors in rooms with windows widely open. Rest being a necessary adjunct to pure air, many of the hours spent out of doors must necessarily be spent in a sitting or recumbent position, the latter being by far the best. The chair of all others most suitable for this purpose is the long deck chair, half chair half couch, so familiar to all ocean travellers. The chair should be placed so as to be sheltered from strong wind, or excessive heat from the sun. Mere cold in the sense of a low degree of temperature, provided the patient be kept warm with rugs and foot-warmers, has no deleterious effect, and this treatment is carried out with the most satisfactory results both at Davos in Switzerland and in Russia. The continuous fresh air soon induces appetite and sleep, essential factors in the cure.

Further details of routine daily life under this method of treatment are considered (p. 195), and

the regulation of febrile cases and other complications discussed.

Wind, Rain, Fog, and Open Air.—To open-air life, wind, rain, and fog are frequently incidental. The consumptive can soon be taught to brave them all. In doing this, however, reason should be exercised, and while the patient learns to abandon chest protectors and other swaddling clothes in which he was wont to be clad, and ceases to fly at the least sign of damp ground or a shower of rain, he must not go to the other extreme and become a reckless fanatic, such as some popular writers would apparently have him. A varied life, at high altitudes, on the sea coast, and at sea; and six months spent entirely in the open air or occasionally only under canvas, have led me to certain conclusions with reference to the open-air life and its effect under different conditions of weather, both upon the healthy and the sick. With the consumptive first introduced to the open-air life, as with the amateur traveller or campaigner, there is apt to be a certain confusion of mind between "open air" and "exposure." The two things are quite distinct, and the necessity of being explicit on certain practical points has been impressed upon me both as a campaigner and a physician. Thus, clothing should be light, but sufficiently warm, preferably of woollen fabric, both in underclothing and dress. And the individual resting in the open air, whether he be a soldier who bivouacs under the canopy of heaven, or the consumptive who reposes in a Liege-halle, or before a widely open window, requires some sort of a protection on his head, unless the weather be tropical.

Wind.—It must be borne in mind that wind has a more cooling effect on the body than a still atmosphere 30° or 40° lower in temperature. The mistral of the Riviera, the trade winds, the

gales of the "roaring forties," the tormenting half-gale of the high veld in South Africa, and the rough breezes on our own hills often occur with a registrably fairly high temperature, but any patient sitting, driving, or even walking slowly in such a wind must have clothing of sufficient warmth. For the patient resting out of doors, shelter from strong wind is essential. To provide an artificial shelter out of doors, where a natural one is not forthcoming, innumerable contrivances have been devised. The German Liege-halle, the summer-house, the small marquee or garden tent, canvas screens, glass screens, all may serve and all be used according to varying local and other conditions, so long as they protect the patient while resting from wind, excessive heat, or rain, and at the same time enable him to breathe abundant pure air. (Figs. 17, 18, 20, and 22 to 30.)

Rain need not alarm the consumptive undergoing open-air treatment, nor will it always be necessary to give up the usual walk; still, experience has led me to recognise that exposure to wet combined with cold is a menace to health, and I have seen hardy colonial troopers prostrated with dysentery as a result of it. As an indifference to wet clothes is sometimes urged, somewhat recklessly, by amateur writers upon the consumptive undergoing open-air treatment, the following are practical instructions on this subject which I am in the habit of giving. As a patient becomes gradually accustomed to the out-of-door life, and is able to take short excursions, he need not desist because of a shower of rain, but the light overcoat and the umbrella should not be despised, and the patient must see that he does not get cold as well as wet. Damp clothes while a man is walking, or riding, or rowing, or taking any form of exercise which serves to keep him warm, do no harm;

Fig. 15.—Up Country Town, South Africa.

if on sitting down wet in cold weather he covers himself with rug or ulster, the chances are he may remain for an hour or so, and still take no harm. But if wet through in, say, an ordinary tweed suit, he sits down uncovered in an open vehicle, a cold railway carriage, a Liege-halle, or anywhere else, until he is thoroughly chilled, he will not by so doing improve his pulmonary condition, and he will run a considerable risk of other complications arising. On this point the traditions of the English hunting-field and the Scotch moor are perfectly sound. A man may hunt all day in the rain without an overcoat, provided the coat he does wear, combined with the exercise he gets, are sufficient to keep him fairly warm. A man may crawl about in morass or burn all day deer-stalking on a wet mountain-side, every stitch he wears may be sodden, but if after the day's sport is over he either walks, or rides a Highland pony home, he will be none the worse for it, and a dry rub or a bath and a change are all he requires. But if the unwary sportsman, wet, weary, and warm, decide to drive home some ten or twelve miles in an open vehicle, with neither rug nor ulster, on a chill October evening, he incurs risk.

Two cases illustrating this came under my notice recently; in one, a drive of this sort brought on an attack of pleurisy, in the other an attack of rheumatism.

The amateur writer on the "Open Air Treatment" is like the amateur traveller described by Younghusband, he is characterised by a "passion for unnecessary hardship."

Fog is not an insuperable objection, but is an undesirable quality in an atmosphere for the phthisical, although fog is better than respiratory impurity. A moist atmosphere has the effect of diminishing the quantity of vapour exhaled in the breath, and so

checks the removal of the organic impurities contained in that vapour which are eliminated from the blood by the process of respiration. In dry air the breath vapour with its organic impurities is freely exhaled from the lung, and this largely accounts for the invigorating effect of a dry atmosphere. The languor so pronounced in low coast districts within the tropics is due to a checking of the evaporation from both lungs and skin, and a consequent accumulation within the body of those effete products which are eliminated in a normal atmosphere by evaporation. For these reasons, in choosing a site for a sanatorium, or other dwelling for a consumptive patient, a spot should be selected which is as much above any local fog that may arise as possible. At the same time, fog does occur at many of the German sanatoria, and need not deter patients from taking their usual exercise unless exceptionally thick.

Ventilation and Draughts.—The open-air life soon teaches a patient to regard draughts as a bogey of bygone days; at the same time, the regulation of air supply in a patient's room requires so arranging as to avoid actual strong draught as much as possible. It is one thing to sit under a hedge, or protected by a deck shelter on the weather side on board ship, it is another to have a narrow, cold draught blowing directly on to a patient in a room. Both conditions provide pure air, the one with comfort and advantage, the other with discomfort and possible disadvantage. A little skill and thought in arranging the air supply for a room generally avoid this. Thus in winter there is no more effectual way of thoroughly airing a room than that originally recommended by Florence Nightingale for the sick chamber, a bright fire and an open window. A free draught is established from window to fireplace, and the patient, either in bed or on a couch, must be

placed out of the line of that draught. By draught I do not mean the merest suspicion of fresh air in a room, which is the interpretation attached to the term by many people, who place sandbags to every crevice. For the atmosphere to remain pure, free movement of currents of air in a room is essential, and in all cold weather the consumptive, either reclining or sleeping in such a room, with windows well open, will require both warm clothing and a cap

Fig. 16.—The Kimberley Sanatorium, South Africa.

to protect the head. The soldier in a bivouac who sleeps in the open air wears a warm nightcap, the consumptive who freely admits a winter's atmosphere to his bedroom equally requires one.

If there be no fire in a room and the outside atmosphere is still, the windows of the patient should be widely opened night and day. If wind blows directly into a room, a closing of one window, and opening of another, or the partial closing of a window, manipulation of a screen, removal of the bed, or half a dozen little resources which a skilled doctor or nurse can devise, or a patient himself arrange, may be used, so as to avoid a direct strong draught.

On the control of air admitted into the patient's room, and other practical details, I recently, while on a visit to the famous little Nordrach sanatorium in the Black Forest, had the advantage of an interview with Dr. Walther, the resident physician there. He said that if he found himself called upon to interfere at all with the windows in his patients' rooms, it was generally to induce them to close, or partially close, a window in exceptionally boisterous weather. The patient once thoroughly acquainted with the open-air life becomes an enthusiast and occasionally requires a little restraint. During cold winter months the room of a patient may require artificially heating; in this case the temperature should not be raised above 45° to 50° F., as the contrast with the outer air is too great. The extent to which free admission of the outer air to a room lowers the temperature is much less than is generally supposed, unless an actual strong current of outer air is passed through the chamber. Bennet, writing of freely ventilated bedrooms in the Riviera, says that between the temperature of a room hermetically sealed and one ventilated the difference is only one of 2° or 3°. On a cold winter's night in England the water may freeze in the water-jug of the stuffiest bedroom; the temperature of that same bedroom with a window partly open would not be more than a few degrees lower. Thus Berthenson says that in the Hospital of the Croix Rouge, at St. Petersburg, when the outside temperature is 20° below zero, the temperature of the rooms being 17° above zero, a free system of ventilation only lowered the temperature 1° in four hours.

To confuse heat with foul air and cold with fresh air are popular errors. A chamber may be fetid below freezing point and contain perfectly pure air at a temperature of 90° F.

Ocean Voyages, high altitudes, and dry climates have all been eulogised in turn as remedies for phthisis. I have had phthisical patients under my care and observation for considerable periods of time under all these conditions, and the conclusion I have

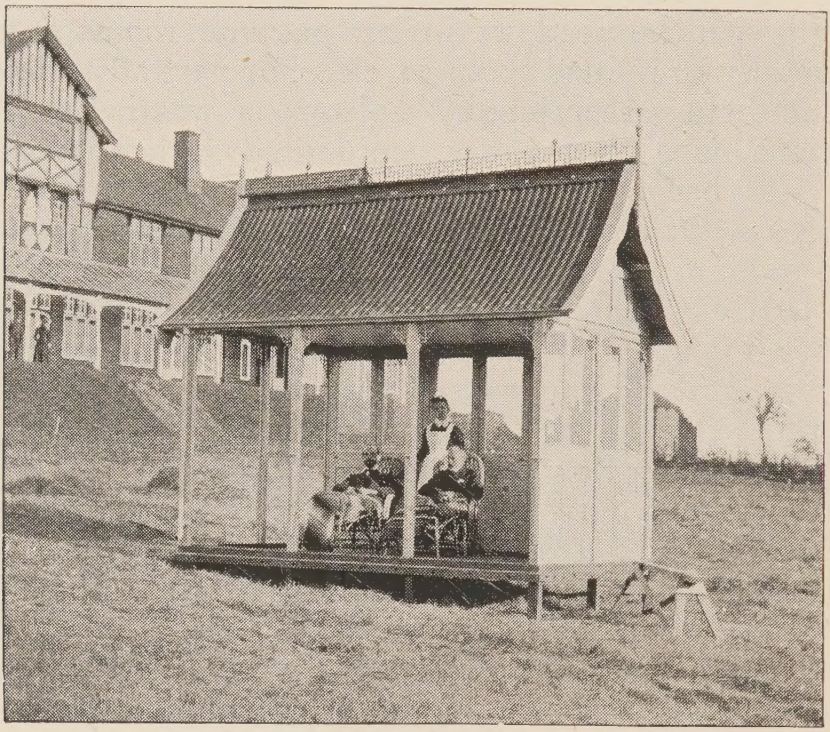


Photo: A. E. Coe, Norwich.

Fig. 17.—Open-Air Shelter, with Movable Glass Panels.—Mundesley Sanatorium.

come to is that the benefit derived in every case is chiefly dependent on the extent to which the patient is continuously kept in pure air. Thus a "sea voyage" is often ordered for the consumptive, not infrequently by physicians who have never made an ocean voyage themselves, and the discomfort of it often aggravates rather than relieves the disease. A deck cabin, the ports of which can always be open during a fine-weather voyage, on a ship which is not

too crowded, offers to an intelligent consumptive patient admirable conditions. But these conditions are seldom all fulfilled, and the very opposite not infrequently obtain. One case I had which furnished me with an object lesson I shall never forget. On a

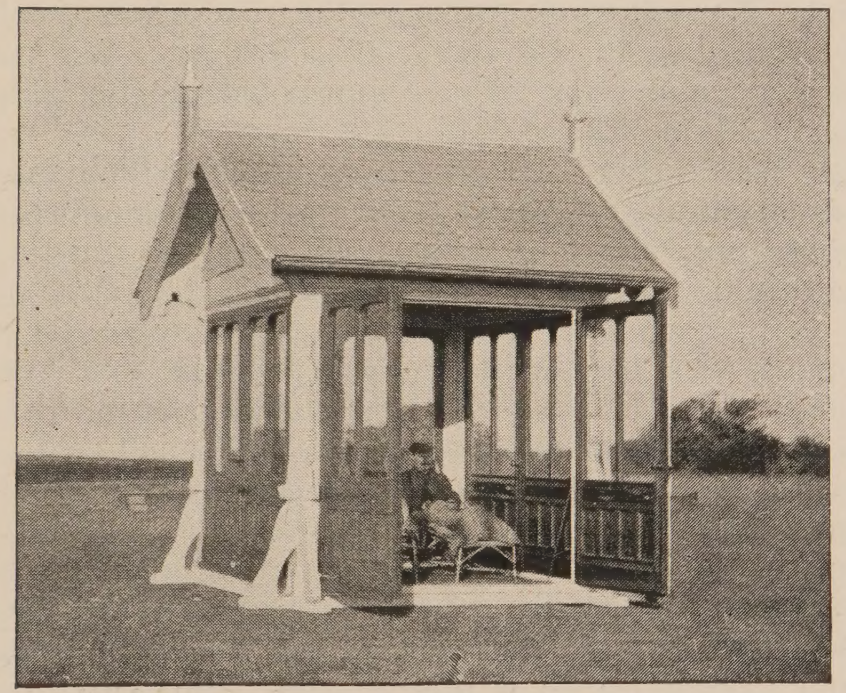


Photo : A. E. Coe, Norwich.

Fig. 18.—Shelter for exposed spot, with glass doors on all sides.—Mundesley Sanatorium.

voyage from South Africa, while in the tropics on a Cape mail steamer, I was asked to see a consumptive passenger in consultation with the ship's surgeon. A stiff trade wind was blowing, and all the ports of the lower cabins on the weather side had to be closed. In one of these cabins far aft, in immediate proximity to the screw, I found the patient. The ship was rolling violently and the vibrations of the screw were felt with painful intensity. The port

(window) was carefully screwed up, the cabin was close and hot. The patient was completing his voyage. He was *in extremis*, and, even if it had been practicable, it would have been useless at that stage to move him on to the wind-swept deck by day only to be carried back in a heavy sea to the cabin for the night. The ship was full, no other cabin was available. He died in the course of a few days and was buried at sea, twenty-four hours before the ship reached Plymouth.

A "sea voyage" is an empty phrase which may mean anything. A yacht given up to the comfort of a consumptive owner makes an excellent floating sanatorium, but no ordinary mail steamer carrying her complement of passengers can compete for a moment with the sanatoria now available on land. Among sailors I have seen numerous cases of phthisis, and two French naval surgeons have specially called attention to the number of deaths from phthisis among sailors in the French navy. The fact is, a man may obtain a comparatively pure atmosphere in the heart of a city if he opens his windows; he may poison himself with foul air, as I have found from actual experience, in a hut on the High Alps or a stuffy ship's cabin in Mid-Atlantic. But further than that, the risk from an old pattern wooden ship, with ill-ventilated cabins, is not confined merely to foul air. These same cabins, often dark, as well as ill-ventilated, offer conditions which have been shown to be most powerful in helping to preserve the virulence of tubercle bacilli outside the host.

Mitchell Bruce has called special attention to the high phthisis rate obtaining among boys on board our old training ships, some of which are wooden hulks, ancient in structure and deficient both in air and light. It is under such conditions as these that phthisis is most readily communicated. Can there

be any reasonable doubt that it is so communicated in the old wooden training ships?

High altitudes and dry climates also depend greatly in their value to the consumptive on local conditions and individual habit of life. Pure air first and everything else afterwards. At the same time, I believe both altitude and dryness of atmosphere have much more claim to consideration as desirable conditions for the phthisical subject than the vague lottery described as a "sea voyage." Having lived for several years at altitudes of from 4,000 to 6,000 feet, in a subtropical climate in South Africa, the stimulating and invigorating effect of the mountain air, though no cooler than that of the coast, has distinctly impressed me in its effect both on the healthy and on the consumptive. Many consumptives, after a month or two on the coast in South Africa, where the air is often heavy with moisture, on finding they are no better, migrate up-country into a higher and dryer atmosphere, and immediately begin to improve. Of this, numerous instances have come under my notice, although the open air life on the coast and up-country had been followed to the same extent in both cases. I am convinced that the hot, heavily moisture-laden atmosphere of low districts in the tropics and subtropics is extremely bad for consumptives, quite as bad, if not worse than the fogs of our own country, as at high temperatures much more moisture is suspended in the air. The rationale of the ill-effects of the fog upon the consumptive was discussed (p. 173), and what was then said is equally true of tropical atmospheres saturated with moisture, although the temperature may prevent the formation of actual fog. It must be borne in mind, as a point of practical importance, that a clear atmosphere at a temperature of 90° F. may contain more moisture than a foggy one at

40° F. To the consumptive in South Africa my advice has always been to live on the high interior plateaux, preferably on a farm or in tents and waggons. The climate of South Africa I have discussed elsewhere.* At Kimberley, the centre of the Diamond Fields, a sanatorium has been opened on the lines of a "first-class hotel, intended as a health resort for ladies and gentlemen seeking pure air as a means of recovering from incipient maladies of the chest and throat. There are no resident or official medical attendants or nurses, and it is not intended for the reception of cases of advanced disease." (Figs. 16, 15, and 14.)

SANATORIA FOR THE TREATMENT OF CONSUMPTION.

Climates of every variety have at one time and another been recommended for consumption. High altitudes and the sea board; warm climates and cold ones; the ocean and the desert; the Equator and the Poles. The underlying truth is at length being recognised. The chief virtue of these different resorts is the open air life. It is true the open air in Germany and England may not, owing to the uncertainties of climate, be as agreeable as that of Davos, the Riviera, or Egypt. But it has this advantage—it is obtainable by German and English consumptives in their own countries, and experience has now shown that results quite equalling those of various vaunted southern resorts are obtainable in sanatoria in Germany and England. In a sanatorium specially established and conducted for the treatment of consumptives, it is obviously possible to combine all the desirable conditions, with an elimination of undesirable conditions, in the open air method of

* "The Climate of South Africa," *Practitioner*, June, 1898. Also "The Geography and Climate of South Africa," *Brit. Med. Journ.*, Dec. 2nd, 1899.

treatment. And this more than compensates for the problematical superiority of climates foreign to either of these countries. The lottery of the sea voyage already described is only equalled by the uncertainty

Photo: E. H. Donty.

Fig. 19.—This shows the house which contains the Kitchen and the Office and Post Office, and is also a Public House. On the right is the Drawing Room.—Part of Nordrach Sanatorium, in the Black Forest.

as to accommodation and food obtainable in some foreign health resorts, *e.g.* South Africa and Egypt.

A visit to Nordrach, Falkenstein, and other sanatoria, as well as the results obtained at these institutions, and an intimate experience of the uncertain conditions which surround consumptives on a sea voyage or in various distant health resorts, have convinced me that the ideal and best form of open air treatment is to be obtained in a well-conducted sanatorium. Another argument has been not unfairly urged in favour of the open air treat-

ment in the country in which a patient has subsequently to live. It is highly desirable that after arrest or cure has been established in a case of phthisis the patient should not immediately go off to a less clement climate. Many instances of this sort have come under my notice in the care of consumptives who have derived considerable advantage from the sunshine and up-country out-of-door life in South Africa, but who have broken down again on having to face an English winter. The man who has braved wind and weather in an English or German sanatorium will more readily stay out-of-doors and open his windows when he gets back to every-day life at home, than one who has just returned from the Mediterranean or the Cape.

Before considering the life of the consumptive in a modern sanatorium, it will be of interest to turn to the other side of the picture for a moment, and consider the surroundings of a patient treated in his own chamber on the old lines.

Michel Peter* has described the scene in terse and decided language.

He says:—

"I know nothing more hideously fetid than the bed-chamber of a rich consumptive. It is a spot carefully enclosed, where both air and hope are alike forbidden to enter; there are sandbags to doors, sandbags to windows; thick curtains envelope the bed, where the unfortunate consumptive swelters in perspiration and an atmosphere twenty times respired, twenty times already contaminated by contact with his own diseased lungs."

To remedy the evils and inevitably fatal results of such conditions as these, accompanied though they be with the most regular doses of the drug latest in favour, the modern sanatorium has come into existence.

* "Leçons de Clinique Médicale."

The sanatoria best known to-day are those already many years in existence in Germany. Of these, the first was that of *Görbersdorf,* in Silesia. This was founded in 1854 by Brehmer, who may be said to have originated this method of treatment. At

Fig. 20.—Interior of the Liege-halle at the Falkenstein Sanatorium.

an altitude of 1,700 feet, Görbersdorf has some of the advantages of mountain air. Dr. Achtermann, the present superintendent, keeps febrile patients at rest in summerhouses, balconies, or a bedroom with widely open windows. The non-febrile are encouraged to take exercise. Two hundred patients are accommodated, and the charges are from £3 to £4 a week.

Falkenstein, in the magnificent Taunus country, near Frankfort, is more modern and luxurious, and more widely known to English patients. The climate here is not at all unlike our own, and both rain and

mist are common. It stands about 1,300 feet above sea level on the southern slope of a wooded hill. Dr. Hess is now medical superintendent, and the name of Dr. Dettweiler, the consulting physician, has long been associated with the open air treatment. He has especially advocated rest in the recumbent position in the leige-halle and other shelters, and maintains that the best way to reconcile patients to the open air life is to introduce them to it lying down. The regular charges here are from £3 to £5 a week, but extras such as stimulants, rubbing, and baths are also charged for. On visiting Falkenstein I was much impressed with the beauty of the scenery and the luxurious appointments of the sanatorium, but the interior arrangements of the building, which was erected in 1876, are perhaps not quite so well adapted to the free admission of the outer air as are the sanatoria on the cottage or pavilion system. In fact, it is almost impossible to make a large massive building, with central corridors and other structural arrangements incidental to large buildings of this description, as freely accessible to the open air as are a colony of smaller buildings similar to those in the Adirondacks in America or at Nordrach.

Nordrach is placed at the head of a romantic mountain valley in the Black Forest. The slopes on either side of the valley are covered with pine and beech, and around the colony itself is a wide amphitheatre of wooded hills, only open directly to the south-west. The institution consists of a colony of small buildings and cottages, with a separate dining-hall. The five buildings used are constructed chiefly of wood, and are simply but comfortably equipped and furnished. No liege-hallen are provided, but a few huts and rustic seats are placed in the grounds, and hammocks are strung by

the patients themselves in the Forest. The climate is much like that of England, and both rain and mist are common. A great feature of the treatment here is the personality of the medical superintendent, Dr. Walther, who combines deep conviction and great natural force of character with an enthusiasm which inspires and cheers everyone of his patients. The largest of the buildings consists of a row of bedrooms on ground and upper floor, all facing south, with a wide passage at the back of each row. The freest ventilation is thus obtained by windows, which in the bedroom have a fanlight above them going up to the ceiling. On the open air question there is no compromise. The windows of the bedrooms are widely and continuously open, except in very cold weather, when they are closed for an hour before the patient gets up, so that he may have a comfortable atmosphere to dress in. In the same way they are closed for an hour before he enters to go to bed, and opened again when once the patient is in bed. The dining-room is closed for an hour before a meal, the windows being thrown open as soon as the patients enter. By this plan no windows are kept closed while a room is occupied, although slight modifications as to closing this or that sash or fanlight are made to prevent excessive draught or discomfort. As a matter of fact, Dr. Walther assured me he not infrequently had to close, or partially close, a window, the patients themselves throwing everything wide open under all conditions. On the question of rain and wet I have already recorded my own experiences. Dr. Walther has on this subject no fixed rules, but advises patients well enough to walk about not to be frightened by a shower, and to protect themselves or not by a coat as they find most comfortable. This seems rational and physiologically sound. Discomfort of at all a pronounced character is one of nature's

danger signals, and to get chilled when wet is to endure discomfort.

A man is not, therefore, compelled by a sort of Spartan *régime*, as one might suppose from certain published descriptions of the Nordrach treatment, to remain all day with sodden boots and clothes on. He is encouraged not to fear wind or weather any more than does the British sportsman, but he is not compulsorily converted into a sort of amphibian. At the same time, moderate exercise, fresh air, and plenty of food soon engender a degree of vitality which enables the patient to dispense with many of the swaddling clothes too often inflicted upon the consumptive. Food is regulated on the same lines. The patient is encouraged to eat freely and fully. Three meals a day are provided and nothing is allowed between meals, which are taken at long intervals. The restful open air life soon develops a keen appetite, and the patient's weight steadily increases.

With air and food are combined rest, and Dr. Walther, who has no liege-halle, makes his patients rest quietly in their rooms on a couch for an hour before dinner and supper. Rest like this alone and undisturbed is, in Dr. Walther's opinion, more valuable than rest taken in a liege-halle, and for practical purposes the bedroom with open windows is a liege-halle. The bedrooms are lined with smoothly planed pine boards, rubbed and polished with linseed oil. These offer a smooth surface and are easily kept clean. The furniture is plain polished deal or ash, with no other special features. There are no hangings in the bedrooms, which have linoleum or plain board on the floors. The couches are upholstered and comfortable. Each room is provided with a shower and two fitted basins, with hot and cold water laid on. The one basin is used entirely for teeth cleaning, the other for washing. In addition to

the ordinary French casement window there is a glass fanlight going up to the ceiling.

Some public health official once expressed to Dr. Walther his misgiving as to the cubic contents of one of the bedrooms which he had just measured. Dr. Walther, turning to the large and widely open window, and pointing to the sky, limited only by a

Fig. 41.—Red Cross Döcker Huts.—Grabowsee Sanatorium.

distant fringe of pines, said, "Ah, you have forgotten something, you have not measured that." A principle on which Walther strongly insists is, that the sanatorium treatment should be largely educational, and he said one of his chief objects was "to teach what can be practised hereafter."

Red Cross Sanatorium on the Grabowsee.—One sanatorium which I visited in Germany was of a different class to any of the foregoing. It was founded by the Red Cross Society, and is intended for a poorer class of patients. It is situated on the Grabowsee, near Orienbad, about twenty miles from

Berlin. It is situated on sandy soil among pine trees on the shores of the Grabow Lake, and is at no great height above sea level. The institution consists of a combination of permanent building and movable war huts, known as Döcker huts. The official report says, the "Döcker huts are quite suitable for housing purposes in the winter, and are preferred by

Fig. 22.—Döcker Hut used as a liege-halle.—Grabowsee Sanatorium.

many patients." The average cost per patient is about 3s. a day, and the patients contribute towards their support according to their ability. They are encouraged to work in a garden or elsewhere, but this is voluntary, and at first they are not allowed to do anything but lie in the shelters, until they are sufficiently recovered to have gentle exercises prescribed for them. The clothing and bedding are disinfected every week in the steam disinfector, which is large enough to admit the whole bed. Each patient has, therefore, two changes of bedding and clothing. Here, as in all other German sanatoria,

the use of the pocket spittoon is strictly enforced, which clearly shows that the working classes are quite capable of being taught its necessity. Any indiscriminate expectoration about the premises or grounds is followed by dismissal of the patient.

British Sanatoria.—There are now in Great Britain several well-established small sanatoria for consumptives, and others are in course of erection. The Victoria Hospital for Consumption, near Edinburgh, is one of the oldest and best known. It was founded in 1894, has fifteen beds, and has since its foundation entirely adopted the open air treatment. The physician to this sanatorium, Dr. R. W. Philip, published some results recently* which are extremely encouraging and of great interest. If in the climate of the east coast of Scotland such excellent results may be obtained, there is little reason to doubt that sanatoria in other parts of England will be successful. Thus Dr. Philip writes: "On many days, when the comfortable robust citizen preferred to warm himself before a good roaring fire, my patients were reclining or walking out of doors with satisfactory results." Dr. Philip has thoroughly convinced himself of the feasibility of the open air treatment during the least clement periods of our year, and publishes a table showing the number of hours, varying approximately from five to nine, spent outside by his consumptive patients during the months of February, March, and April of 1899. He states that while the open air treatment has never in his experience produced untoward consequences in the slightest degree, it has, on the other hand, produced positive results of the most satisfactory and far-reaching character.

In Norfolk, Dr. Burton Fanning, who has written a good deal on the subject, has obtained excellent

* *Practitioner*, July, 1899.

results, and now has a private sanatorium. Dr. Jane Walker has also treated consumptive cases successfully on the open air methods in Norfolk for some years past.

At Nordrach-upon-Mendip a sanatorium has been established for a year under Drs. Thurnam and Gwynn. They have followed closely the methods in vogue at Nordrach in the Black Forest, and are now obtaining marked improvement in the majority of cases under their care. In addition to the foregoing, several other sanatoria are being started, but unfortunately they are for the most part limited in accommodation and high in their charges. The London Open Air Sanatorium has recently acquired a beautiful site near Ascot on sandy soil among pine trees, with a southern aspect, and fair elevation. When completed it will accommodate sixty-two patients, and the charges will in the case of some of the patients be lower than those usually made. One of the difficulties to be contended with in England is the obtaining of suitable sites at a price which is not prohibitive. Dr. Thurnam states that he spent two years in inspecting and rejecting sites before selecting Nordrach-upon-Mendip, and I was engaged for over six months in seeking through the home counties a suitable site for the London Open Air Sanatorium. In course of time it is to be hoped that sanatoria will be started in the vicinity of all our large towns, for poor as well as rich.

Results obtained at Different Sanatoria.—In Germany a large number of statistics have already been published by some of the long-established sanatoria. Unfortunately there is no uniform system of recording either the nature of the cases or the results obtained, so that it is sometimes difficult to institute comparisons between the results of different

sanatoria, but, broadly, the results are eminently satisfactory.

Weight is greatly increased in the large majority of cases, the local lesions improved or cured, and the general condition markedly better after a residence of a few months. Dr. Walters* has compiled a number of statistics from various German sources and published others in his recent work.

Thus he says that at the Rehburg Sanatorium 297 consumptive patients were treated from June 1st, 1893, to the end of 1896. Of these on entry 71 were slightly affected, 97 moderately affected, 129 seriously affected. The results were:—

	Better.	Unchanged.	Worse.
Genl. Conditions	253 = 85·2 p.c.	20 = 6·7 p.c.	24 = 1·2 p.c.
Local Conditions	63 = 21·2 p.c.	194 = 65·3 p.c.	40 = 13·5 p.c.

Of the more serious cases 75.2 per cent. increased in weight, and of the slighter cases 81.8 per cent.

The statistics for eleven years, published by Manasse†, of the Brehmer Sanatorium at Görbersdorf, deal with 5,032 patients from 1876 to 1886 inclusive. All stages of the disease were received, and the results are significant and instructive.

Stage of Disease.	No.	Cured.	Nearly Cured.	Total Improved.
I.	1,390 = 27·6 p.c.	387 = 27·8 p.c.	430 = 31 p.c.	817 = 58·8 p.c.
II.	2,225 = 44·2 p.c.	152 = 6·8 p.c.	325 = 14·6 p.c.	477 = 21·4 p.c.
III.	1,517 = 28·2 p.c.	12 = 0·8 p.c.	33 = 2·3 p.c.	45 = 3·1 p.c.
	5,032	551 = 11 p.c.	788 = 15·6 p.c.	1,339 = 26·6 p.c.

* "Sanatoria for Consumptives."

† "Die Heilung der Lungentub. durch diätetisch hygienische Behandl. in Austalten und Kurorten." Berlin, 1891.

The extreme importance of beginning to treat cases in the first stage of consumption is here apparent. In these 5,000 odd consumptives the prospects of improvement in cases in the first stage to those in the third were as 58·8 to 3·1. The moral is obvious. The consumptive, the moment his disease is diagnosed, should shape his life accordingly. He has no time to lose. The sword of Damocles is suspended over him until a cure is obtained. Numerous other statistics, some better and some worse, are quoted. It is probable that Dr. Walther's returns from Nordrach, if he ever publishes them, will be among the best, if not the best, yet obtained. With regard to the permanence of the cures, special inquiries were made in 1890 as to the results obtained both at Brehmer and Falkenstein. In reference to these Walters says that of 40 patients discharged as cured or nearly cured by Brehmer in 1876, it was found that there were 25 still in good health, while one suffered from fibroid phthisis, one had died four years previously from phthisis, and 13 had died from unknown causes. From inquiries made by Dettweiler at Falkenstein in 1886, he found that 72 out of 99 patients who had left as cured were living from three to nine years after in perfect health, in 15 cases there had been relapse, although 12 out of the 15 eventually recovered.

Thus it is clear that the good results of treatment are permanent in a large proportion of cases. From these results it is interesting to turn to the few returns as yet made from British sanatoria. Dr. Philips' testimony as to the results obtained near Edinburgh has already been quoted.

Dr. Thurnam* publishes a list of 24 cases under treatment at Nordrach-upon-Mendip, of which eight have already left cured or improved, and of the

* *Practitioner*, July, 1899.

remaining cases still under treatment in the sanatorium nearly all have considerably increased in weight and improved in general condition. Dr. Burton Fanning published a record of 24 cases in 1898,* in which he expresses the total results as follows:—

"Number of cases, 24; cured, 2; relatively cured, 4;

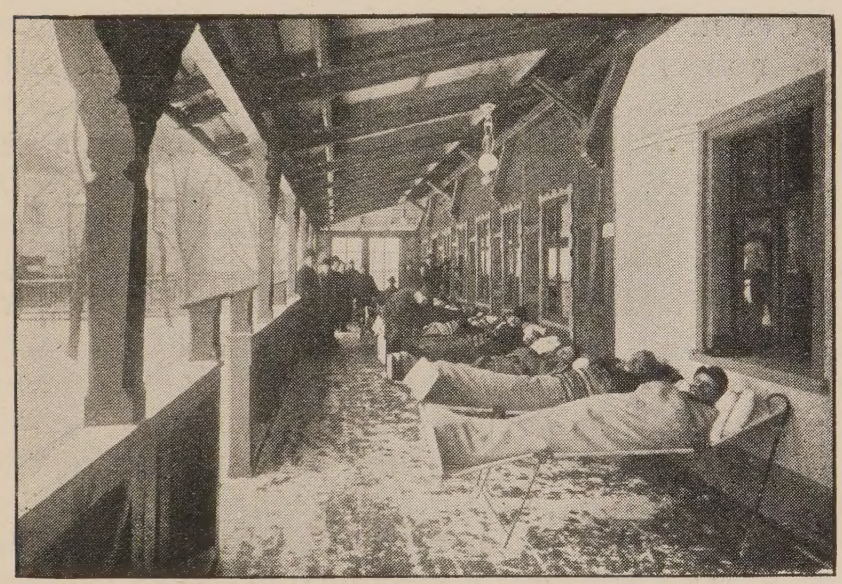


Fig. 23.—Liege-halle in Dr. Weicker's Krankenheim in Görbersdorf.

improved, 12; only temporarily improved, 6. The average duration of the patient's stay in the home was three and a half months; the longest time any patient was allowed to remain was fourteen months. The average gain in weight made by the patients during their treatment at Cromer was 8½ lb.; the maximum gain was 22 lb., which one patient added to his weight in six months."

The prospects for the sanatorium treatment in England may be said, in view of such results as these, to be probably quite as good as in Germany.

Taken all round, sanatoria consumptives show returns equal to, if not better than, the health resorts

* *Lancet*, March, 1898.

of high altitudes, such as Davos. Of cases taken in all stages the results far surpass those obtained in general or chest hospitals, while of those taken in the first stage from 50 per cent. to 75 per cent. are either cured or improved.

Requirements of a Sanatorium. — The object of the sanatorium for consumptives being to offer, in its best and most convenient form, that open air treatment which has already been considered, it is now necessary to state more definitely the requirements of such a sanatorium, and the practice to be observed in the every-day life of the patients in them. As will be gathered from the brief accounts given of different sanatoria, the practice varies in some points with the views of the resident physicians and in others with modifications required by local conditions. A sanatorium should, if possible, be placed on the south side of a hill, at a sufficient height above sea level to obtain a bracing air, with woods in its near vicinity, and some acres of ground belonging to it for the arrangement of liege-hallen, summerhouses, graduated walks, etc. The soil should be sandy or on rock, and thoroughly dry, with a slope to ensure free drainage. While a climate as dry as is obtainable should be sought in selecting a sanatorium, the conclusion which results obtained in consumptive cases in South Africa, in the Riviera, on ocean voyages, in Germany and elsewhere point to is unmistakable. There is no climate entirely immune to phthisis, and there is none so bad as to preclude the hope of recovery under rational open air treatment. The structure of sanatoria does not require any hard or fast rules. One of the best, Nordrach, consists of several buildings, some of which have been converted from other purposes. The plan we are following in the sanatorium about to be erected by the London Open Air Sanatorium Board, after

inspecting and considering numerous sanatoria already in existence, is that of a central administrative block with dining- and sitting-room, etc., and separate blocks of bedrooms. The bedroom blocks, four in number, are two stories high, and on both floors the south front consists of bedrooms with

Fig. 24.—Rest Cure in Summer.—Albertsberg Sanatorium.

windows and fanlights to the ceilings. Behind, on each floor, runs a wide passage freely ventilated by windows. This plan is simple, and affords the best facilities for abundance of fresh air. What artificial heat may be required in winter will be supplied with hot-water pipes. Bathrooms, douches, W.C.s, and attendants' room, all open off the passages on the north side.

Principles of Treatment in a Sanatorium.—Dettweiler, whose experience is unrivalled, has said that the best way to reconcile a patient to the

open air life is to introduce him to it lying down. For this purpose a deck chair should be placed in a sheltered spot, and the patient made thoroughly comfortable with plenty of cushions, rugs, and sufficiently warm clothing. As the patient gets gradually accustomed to the out-of-door life, neither snow, rain, nor even mist need necessarily deter him from resting in this manner, provided he be properly sheltered and covered. Sunshine should be obtained wherever possible, and not too hot, both out-of-doors and in the rooms. As the condition of the consumptive improves, and will allow of it, gentle walking exercise, such as Walther prescribes, at about two miles an hour, may be taken, although in all cases an hour's rest before dinner and supper should follow quietly in the patient's room, and even during the walks the patient should rest freely if he feel in the least fatigued. The sitting position for any length of time is not a good one for the consumptive. The circulation to the feet goes on more readily and completely when the legs are stretched out, and the whole body is more easily kept warm, both naturally and artificially, with the aid of wraps, in the recumbent position.

At night the bedroom windows should be freely open, except in winter, for an hour before the patient goes to bed, and an hour before he gets up in the morning, so that he may have a mild, still atmosphere to dress and undress in. One advantage of making the patient rest in his own room on a couch during the daytime is that he learns to make a liege-halle of it. In cold weather, well wrapped up, both head and foot, he lies on the couch with windows widely open, and by this experience he is more readily reconciled to a widely opened window at night, against which he should fortify himself, if necessary, by wearing a warm night-cap. On the open air question there must be no compromise, if the best

results are to be obtained. The air cannot be too pure; it may at times be unpleasantly cold, and against this disadvantage clothing in its broadest sense provides an ample remedy. Woollen material combines lightness with warmth and is most suitable. As to food, it is only next in importance to pure air,

Fig. 25.—Rest Cure in Winter.—Albertsberg Sanatorium.

and Dettweiler says, "Ma cuisine c'est ma pharmacie." Appetite is one of the first results of the open air life, and the good digestion which should "wait on appetite" rapidly follows. The practice as to number of meals varies in different sanatoria. At Falkenstein they have five, at Nordrach three. The latter plan I believe to be the best, and Dr. Walther lays great stress on the patients taking no food between meals. The close supervision of each individual case and the modification of the treatment necessary in each case by the medical man are, of course, essential.

With regard to the conditions under which walking exercise should be taken, as well as the treatment in febrile cases, a difference exists at various sanatoria. In some instances febrile cases are confined to their rooms with windows open; in others, unless the evening temperature be over 102°, they are, and I think wisely, kept out-of-doors in a liege-halle or other shelter, on long chairs, or couches. Temperature rather contra-indicates exercise, although a small evening rise need not deter a patient from taking a moderate amount in the early part of the day. Daremberg speaks of the evening temperature in his own case as one of the first things which began to pass unnoticed by him while living *au grand air*, but he nevertheless deprecates exercise where fever exists to any extent. His remarks on exercise and its relation to fever are worth quoting, the more especially as among Englishmen there is a slight tendency to overdo exercise when once it is begun. The open air life of the consumptive should be Spartan in its simplicity, but not in its severity. Thus Daremberg says: "La cure d'air doit se faire au repos. La fatigue et par conséquent la marche exagérée sont les grands ennemis des phtisiques. Il faut leur doser la marche comme on leur dose les médicaments. Quand un tuberculeux n'a pas de fièvre, il peut fort bien marcher une heure le matin et deux heures l'après-midi. Mais s'il a de la fièvre le soir, il devra faire la cure d'air au repos, sur sa chaise longue, depuis le déjeuner jusqu'au coucher du soleil. Le matin il pourra faire une promenade d'une demi-heure ou d'une heure selon l'état de ses forces, le phtisique doit toujours se reposer avant qu'il sente la fatigue. Si, après une promenade matinale, il constate que sa température a été plus forte dans l'après-midi, le lendemain, il fera la cure au repos pendant toute la journée. Je connais un grand nombre de phtisiques

qui à la suite d'une courte promenade faite pendant l'après-midi, voient leur température monter de 4 à 5 dixièmes, puis baisser au degré normal un quart d'heure après qu'ils se sont étendus. Chez une phtisique avancée, j'ai vu la température monter d'un degré après l'ascension de deux étages. Le phtisique ne doit jamais marcher pendant les 2 ou 3 heures qui précèdent le moment de la fièvre vespérale."

Walther, at Nordrach, insists, as a rule, on absolute rest when the temperature rises over 100°. When the temperature has been not higher than this for a week a small amount of exercise is allowed. In South Africa, with patients living a "veldt" or up-country farm life, I have been in the habit of allowing a small degree of exercise in the early part of the day, in spite of a slight evening rise, with good results; but I have always ordered such cases to their rooms before sunset, as the temperature of the atmosphere rapidly changes, and there is an increased danger with a febrile case of getting chilled.

One of the precautionary and educational measures necessary to the sanatorium treatment is the proper disposal of the sputa of the consumptive. Spittoons should be provided in the bedrooms and liege-hallen. In addition to this, every patient should carry his own private pocket spittoon for use at meal times or when walking in the grounds or elsewhere. The spittoons should contain a 1 to 20 solution of carbolic acid, or other disinfectant, and the contents should be thrown in a drain or burnt and spittoons boiled every day. Any spitting in the grounds or elsewhere than into a spittoon must be rigorously prohibited. The vital importance of the use by the consumptive, under all conditions, of a spittoon has not yet been sufficiently appreciated, but if tuberculosis is to be exterminated their universal employment by consumptives is essential.

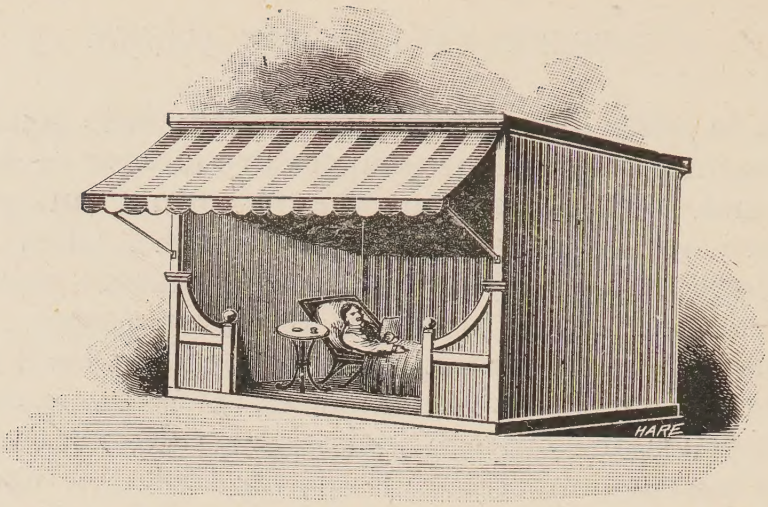


Fig. 26.

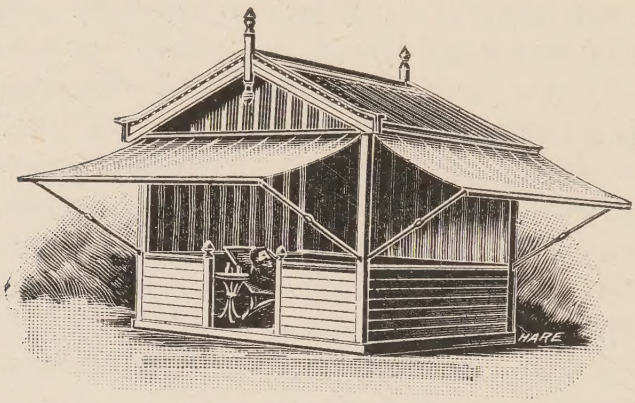


Fig. 27.

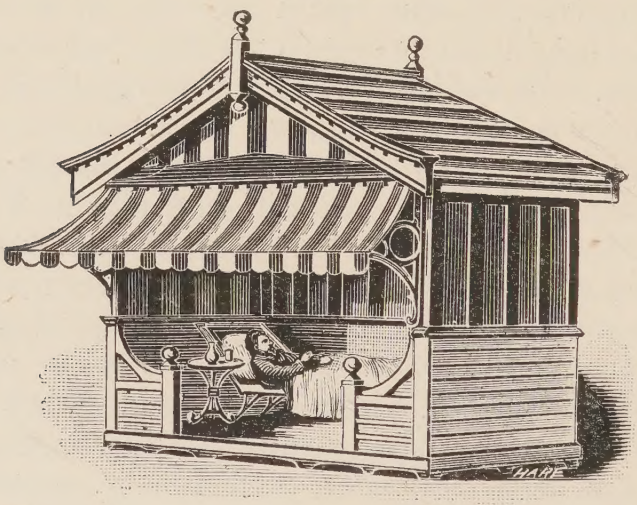


Fig. 28.

Different Forms of Open Air Shelters, from designs by Messrs. Boulton & Paul, Ltd.

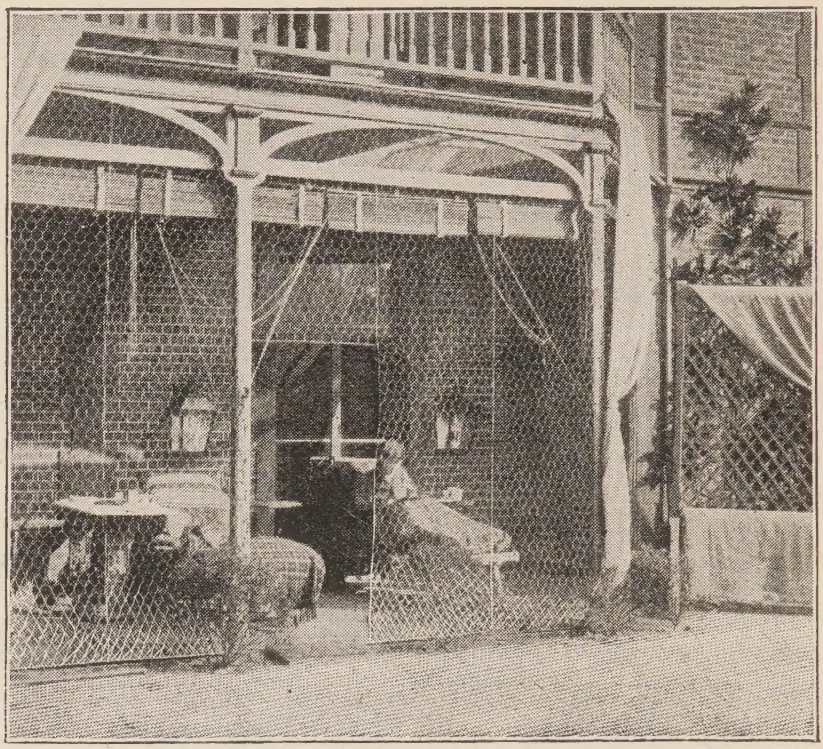
For this reason stringent regulations as to their use should obtain in sanatoria, which should be educational as well as curative establishments. The different kinds of pocket spittoons are shown and described on page 128. To further minimise danger from possible tuberculous dust, a danger which may in a small measure arise, even with the most complete use of spittoons, from drops of expectorant material involuntarily ejected in coughing, the hangings and furniture of all rooms should be as plain and readily capable of disinfection as possible. Thus the bedroom may have linoleum on the floor and painted or polished wood walls. The risk from this source is, however, not extreme, and Dr. Walther provides his patients with a comfortably upholstered couch in their bedrooms.

* * * * *

In brief, the principles of sanatorium treatment may be summarised as follows: Pure and abundant open air by day and night, indoors and out. Such good and plentiful food as the simple open air life may enable a patient to digest. Rest—frequent and complete rest. A long night of sleep, an hour's rest after walking, spent quietly on a couch in the patient's bedroom or elsewhere, with books or papers or occasional correspondence before meals. Even more rest where the individual may require it, and in all cases absolute avoidance of fatigue. Add to this, rest from anxiety, which improving health and the enthusiasm of leader and led confer, and you have the sanatorium treatment. And a rational and scientific treatment it is, beneficial alike for phthisis and half the other chronic maladies that human flesh may be heir to or acquire. Contrast the sanatorium for a moment with any other form of the open air treatment at different resorts and the advantages are perfectly obvious. No ocean steamer

or hotel can equal the advantages offered by a well-conducted sanatorium, where a resident medical man is in constant supervision, and the whole life of the institution is specially regulated to meet the requirements of the consumptive.

Open Air Treatment in a Private House.—While a sanatorium is probably the best of all



By permission of Dr. Francis Pott.

Fig. 29.—Sheltered Verandah and Balcony.

places to obtain the requisite treatment in, there is no reason why it should not be carried out in a private house, especially one situated in the country. Where this is done, a medical man should be consulted as to the arrangements specially required in any particular house, and should also continue a close supervision of the case. At present the

sanatoria available in England are not numerous, and I have seen several patients who have derived very marked benefit from this form of treatment in their own houses. One case is of such interest as to be worth recording. A gentleman with a comfortable house in Hertfordshire has a large family, of which one son died a few years ago of phthisis. He was treated on the old lines and kept carefully confined to his bedroom. Since then one of the daughters of the family has developed pulmonary tuberculosis, and as soon as it was detected she was treated at home by the open air method under medical advice. She has gained in weight and health, and already her father is now asking, with some bitterness, why his boy was not also treated in this manner. Whatever other form of treatment may come to be consigned to the long list of out-of-date remedies, the lesson of pure air is being taught and learned by the civilised world to-day—never again to be forgotten. A perusal of what has already been written in this chapter will clearly indicate the lines on which this treatment in a private house may be successfully carried out. A small liege-halle, suitable for use in a private garden, is shown on page 207.

Treatment in General and Special Hospitals.—The treatment of consumptives in the large general and special hospitals and poor-law infirmaries situated in towns and cities requires a few words. The partial isolation, which the system of treating poorer consumptives in England by sending them into hospitals accomplishes, has doubtless been beneficial to the public, placing a certain number of cases under more sanitary control than would obtain if these cases were left in their own crowded houses and streets. Hitherto but little effort has been made to apply the open air methods in these institutions,

and the difficulty of doing so is quite obvious. The heart of a city is not a desirable site for a consumption hospital. The hospital has neither the purity of atmosphere around it which is required, nor has it at all efficient means of enabling its patients to enjoy to best advantage such atmosphere as it has access to. The grounds, if any exist, are necessarily limited and surrounded by noise and dust. Moreover, the mingling of consumptives with other patients is not a desirable arrangement. Under proper precautions the risk of communication of the disease is reduced to a minimum; but it does exist. This objection applies with special force to the so-called "Chest Hospitals," where many of the very cases most liable to become affected by pulmonary tuberculosis, such as bronchitis or old pneumonias, are mingled with those already suffering from tuberculosis. The out-patient departments of the large hospitals offer greater facilities for taking measures to check the spread of the disease than for curing it. The bottle of medicine which the consumptive takes back with him from one of these visits to his tenement in the poorer quarters of a great city will not avail him much in the absence of pure air, abundant food, and rest. But he can at least be instructed as to the disposal of his sputa, and the danger to his friends and family which carelessness in this respect entails upon them. Leaflets on this subject should be systematically supplied to every consumptive attending an out-patient department, as well as a cheap pocket spittoon, the use of which should be insisted on. Such a spittoon (shown p. 120) is now obtainable at sixpence, and they could be made in large quantities at even a lower rate. The application of what is now absolutely proven about tuberculosis must be carried out if this disease is to be prevented. It is no use telling a consumptive not to spit here, there, and

everywhere unless he be taught and shown where to spit. A cheap pocket spittoon is the one solution of the problem at present available. In the light of our present knowledge these measures are a duty incumbent on all hospitals, institutions which are dependent on public charity for their maintenance, and exist primarily to administer to the public welfare.

The use of a portable spittoon is as essential to the control of tuberculous sputum, as the control of tuberculous sputum is to the prevention of the spread of tuberculosis.

TREATMENT OF SPECIAL SYMPTOMS.

Wherever the consumptive be treated, certain conditions may arise which call for special treatment.

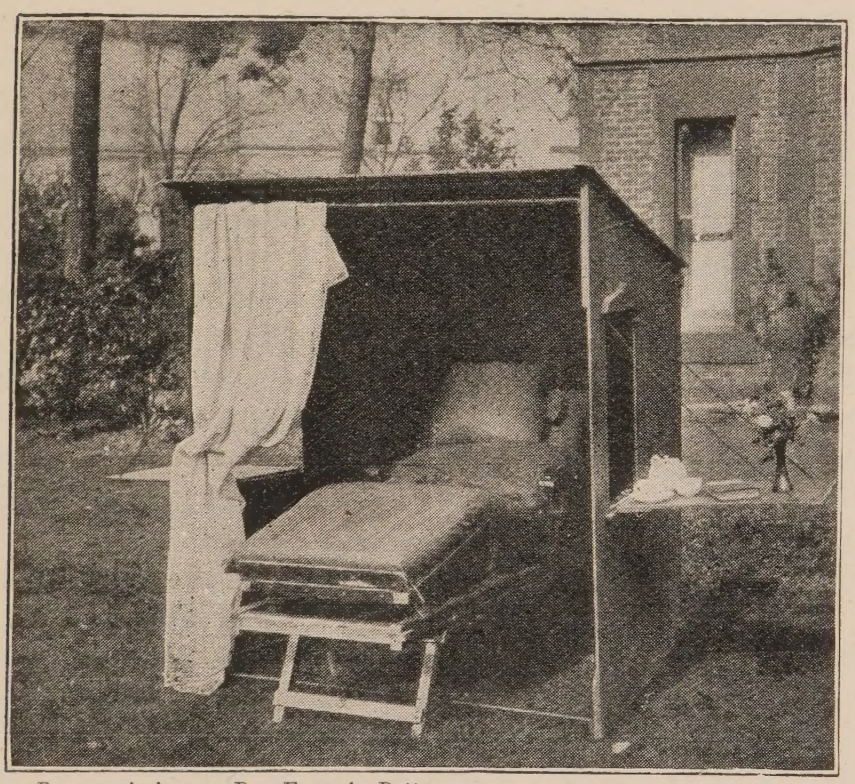
Fever has already been referred to as a factor to be carefully considered in the open air treatment (p. 198). For the reasons already given, we believe this symptom to be invariably associated with mixed infection, and there is nothing in these cases which can be more readily applied than pure air; the antiseptic action of such air is recognised, and it follows that the open air treatment on the lines already discussed is the best treatment for this condition. Numerous drugs are commended, and their number is, perhaps, the best evidence of their inefficacy.

In administering "antipyretics" this question has to be considered. If sufficient doses, say, of antifebrin, antipyrin, or quinine, be administered to reduce the temperature, is the patient any the better for them? Is there the slightest evidence that any one of them actually combats the toxic effect of which fever is merely the evidence? and if it does not, may it not do more harm than good? As to the mere "febrifuge," or "antipyretic" effect of these and other drugs being

of real and permanent benefit in the fever of phthisis, I confess myself, after experience of their use, entirely sceptical.

Hæmoptysis may occur at any stage of pulmonary tuberculosis, sometimes preceding any other physical sign, sometimes fatally terminating the disease. It may proceed from active congestion of lung tissue, or from ulceration, in the early stages of tubercle. In later stages it may result either from ulceration into a vessel, or from the bursting of an aneurism into a cavity. The objects theoretically aimed at in treatment are described by Wilson Fox as being to retard or tranquillise the circulation, to contract the vessels of the lung, and to increase the coagulability of the blood. Of these, probably the one which is certainly capable of partial attainment is tranquillising the circulation by rest. Where the hæmorrhage is early and not profuse, it is doubtful whether prolonged rest in the horizontal position is the best form of rest to apply, as it induces a certain amount of hypostatic congestion which may aggravate the condition; slight movement in a room to a chair or couch is, therefore, occasionally beneficial, though the movement must be slight and not enough to accelerate the pulse. In cases of more profuse hæmorrhage proceeding from ulceration of a large vessel, or the bursting of an aneurism, the patient should be laid on the side from which the hæmorrhage proceeds, so as to minimise the risk of blood being drawn into the bronchi of the opposite lung. Ice is occasionally given to the patient to suck, and occasionally placed in little bags over the supposed site of the lesion—ergot, acetate of lead, tannic acid, and latterly chloride of calcium, have all been administered for hæmoptysis, but it is extremely difficult to estimate their real effect. They certainly do not arrest hæmorrhage proceeding from a ruptured aneurism, and in the

slighter cases of hæmorrhage from congestion recovery occurs spontaneously without the aid of drugs, even in some cases which insist on moving about. Osler emphasises the fact that some styptics produce a fall in the systemic blood pressure, and at the same time



By permission of Dr. Francis Pott.

Fig. 30.—Suntrap.—For use in garden of private house.

a rise in the pulmonary blood pressure. Bradford says that ergot has the effect of causing a rise in the blood pressure of the pulmonary circulation. Personally I still prefer opium to any other drug. Ergotinin in doses of $\frac{1}{1000}$th grain is strongly recommended by Sir T. Grainger Stewart, but for the reasons given I cannot personally recommend it.

Pain is not very common in pulmonary tuber-

culosis, but in tubercular meningitis the pain and unrest are frequently most acute and distressing. There should be no hesitation in such cases to use a sufficient quantity of morphia to relieve and allay this condition of suffering. In affections of the serous membranes, pleura, pericardium, and peritoneum the pain is often severe and requires similar relief.

Sweating of phthisis is one of the first symptoms to abate with the open air treatment. Where very profuse, it may be checked by $\frac{1}{120}$th to $\frac{1}{60}$th grain of atropine, and in such cases light flannel nightshirts or pyjamas should be worn.

Cough.—Coughing is an act chiefly but not entirely involuntary in its nature, whereby the patient suffering from pulmonary tuberculosis is enabled to expel some of the noxious products of his disease. Interference with it by expectorants, etc., must therefore be undertaken with caution. At times, however, the cough is dry and irritating, achieving little in the way of actual expulsion of sputum, and adding a great deal to the distress and even exhaustion of the patient. For the relief of the condition, whether it occur at night, thus keeping the patient awake, or whether it occur in the morning after a night's sleep, I believe the warm drink of milk, or in the morning of coffee, to be the best remedy. Expectorants are apt to upset the stomach, and should only be used if the warm drink fails to relieve. Creasote and iodine inhaled undoubtedly do appear in some cases to relieve the paroxysms of irritating cough, and one patient who had been advised to proceed to South Africa by Sir R. Douglas Powell, and who was continuously under my observation for five years, invariably resorted to his Coghill's pocket-tube if troubled with cough, and with it he declared he always obtained great relief from the dry, irritating

cough, which is particularly liable to worry phthisical patients in exceptionally dry climates. The formula for this preparation, which was one of Dr. Coghill's favourite remedies, was :

℞. Tinct. iodi. ætherealis.
Acidi carbolici, āā ʒ ij.
Creasoti vel thymol, ʒ i.
Spirit. vin. rect., ad ℥ i.
M.

Whether the soothing effect of such an inhalation as this is purely an antiseptic one is not quite certain.

A dry atmosphere is sometimes productive of unnecessary coughing in the consumptive, and Daremberg recommends that damp cloths should be hung in a room the atmosphere of which becomes unduly dry.

But for the cough, as for the fever of phthisis, the sovereign remedy is that which combats the disease producing the cough—the open-air treatment. The diminution in the frequency and severity of the fits of coughing is one of the symptoms specially commented on by Daremberg as occurring in his own case when he left his tainted chamber in Paris to live *au grand air*. And, further, the open-air life eliminates a not uncommon cause of cough, attacks of catarrh, which are often followed by an obstinate and exaggerated cough in consumptive cases.

Dyspepsia may occasionally require a little calomel and soda, or other stomachic or tonic remedies, though here again the open air acts like a charm. Salicylate of soda may be used in troublesome cases of dyspepsia. A modification of diet in some cases is also necessary.

Diarrhœa.—Bismuth and Dover's powder, or lead and opium pill, may be used. If it be of a chronic character, small doses of castor oil and opium often give relief.

SPECIFIC TREATMENT—TUBERCULIN.

That the discovery and exposition of the etiology of tuberculosis should have induced the discoverer to endeavour to find a specific remedy derivable from the tubercle bacillus was natural. And no unprejudiced person can withhold from Professor Koch a considerable degree of sympathy in the disappointment to himself, as well as others, which was entailed by the first endeavours to prepare and apply such a remedy. That the results of tuberculin as a curative agent in tuberculosis have hitherto been disappointing is known to, and deeply regretted by the world at large. But in spite of this the researches with reference to tuberculin have led to the discovery and practical use of an agent which, as a diagnostic test for the presence of tuberculosis in cattle, is of an immense value both to the consumer of milk and the breeder of stock. And although thus used it cannot actually cure tuberculosis, it can and does, if practically applied, largely contribute to the prevention of it both in animals and man. A description of this test as used in cattle is given in the Appendix.

In considering the application of tuberculin in any of its now numerously modified forms, as an agent for conferring immunity from, or for curing tuberculosis, there is one peculiarity about the disease which distinguishes it from the majority of other infectious or contagious constitutional diseases of micro-organic origin. One attack of tuberculosis does not confer any degree of immunity from subsequent attacks. Where a degree of immunity is conferred by a first attack, as in smallpox in man, or pleuro-pneumonia in cattle, artificial immunisation by inoculation has been found practicable. In tuberculosis no immunity, either naturally or artificially induced, has yet been recognised, or at least satisfactorily established. In

Photo: A. E. Coe, Norwich.

Fig. 31.—**Mundesley Sanatorium. South Front.**

syphilis, another of the granulomata, to which group of diseases tuberculosis belongs, some degree of immunity from subsequent attack is conferred by a first attack, but in tuberculosis there is none whatever. *Primâ facie*, then, the prospects of discovering a preventive, much less a curative tuberculin, do not appear great. Nevertheless, Professor Koch has pursued his researches with indefatigable energy, returning to them afresh in 1897, and a record of this work, which in spite of apparent improbability may even yet be crowned with success, deserves our careful consideration.

Koch's first experiments were with guinea-pigs. The results which he then obtained have not always, in other hands, been similar, but those which led him to advocate tuberculin in 1890 as a remedy for tuberculosis in man were as follows. He found that a healthy guinea-pig, and a guinea-pig already inoculated with tuberculosis, reacted very differently to subcutaneous inoculation of tubercle bacilli or of dead cultures of tubercle bacilli. In the case of the tuberculous guinea-pig, ulceration was found to occur at the tubercular nodule, the site of the primary inoculation. The wound thus caused eventually healed, and the animal did not die. There thus appeared to Koch to exist in cultures of tubercle a substance exercising a healing effect in tuberculosis, and an extract supposed to contain this substance was prepared and styled by Koch "tuberculin." For the preparation of tuberculin Koch took a veal bouillon containing 4 to 5 per cent. glycerine and 1 per cent. peptone, inoculated it with tubercle bacilli, and kept it at a temperature of 38° C. for six or eight weeks in a shallow layer in flat bottom flasks. At the end of this time there was an abundant growth with copious film formation. The cultures were then evaporated to one-tenth of their bulk, and the bacilli

were killed by exposing them for an hour to a temperature of 100° C. The result of this process was *tuberculin*, and it evidently must have contained dead tubercle bacilli and whatever they contained.

As with guinea-pigs, so in a measure with man, the difference in the result of inoculation into a healthy and tuberculous individual is very marked. "The injection of 25 c.c. of tuberculin into a healthy man causes, in three or four hours, malaise, tendency to cough, laboured breathing, and moderate pyrexia, all of which pass off in twenty-four hours. The injection (the site of injection being quite unimportant), however, of ·01 c.c. into a tubercular person gives rise to similar symptoms, but in a much more aggravated form, and, in addition, there occurs around any tubercular focus great inflammatory reaction, resulting in necrosis and a casting off of the tubercular mass when this is possible." (Muir and Ritchie.) Unfortunately, however, even if this process actually occurred as described, there were two complicating factors which entirely prevented its being of any benefit to the patient. The first was that the tubercle bacilli in the tubercular focus were not destroyed, but remained alive and active; the second was that the necrosed material containing the living bacilli was neither got rid of naturally nor could be removed artificially. Further, the ulceration which occurred around the necrosed portions offered paths for fresh infection. Disappointment thus followed the use of tuberculin as a means of treatment for tuberculosis. Virchow adduced cases in which rapid, acute tubercular conditions followed the use of tuberculin; and in England Drs. Theodore Williams and Tatham, after a somewhat prolonged trial of tuberculin, reported "that the tuberculin did not favourably influence the course of the disease in the majority of cases, that in some the effects were detrimental, and that even in the

stationary and improved cases it was difficult to ascribe any distinct improvement to the injections which might not have been equally attained under the treatment ordinarily employed in the hospital."

Klebs, Hunter, Crookshank, Herroun, Kühne, and others investigated the toxines of the tubercle bacillus, and Maragliano has treated many cases with serum containing them; so far, however, no very reliable results can be definitely assigned to this form of serum treatment. In 1897 Koch published some further results of his researches on tuberculosis and tuberculin. These were based on the fact that a guinea-pig inoculated with tubercle and allowed to die naturally, contained tubercle bacilli in its lesions which appear in a measure to have lost their virulence, it often being impossible to obtain cultures from them. From this Koch inferred that the last stages of the animal's disease were due to the absorption of intra-cellular poisons, and that immunisation against such poisons would probably be beneficial in cases of tuberculosis.

For the purpose of extracting these poisons, Koch triturated dried cultures of bacilli in an agate mortar, added distilled water, and centrifugalised. The material was thus separated into two layers—an opalescent, supernatant fluid called Tuberkulin Oberst, T.O., and a colloidal portion in which a few tubercle bacilli may generally be found called Tuberkulin Rest, T.R. Tuberculin O. when injected acts very much like the original tuberculin. Tuberculin R. Koch submitted to further drying, pounding, extraction with distilled water, and centrifugalisation, until no more tubercle could be found in it. He then added 20 per cent. of glycerine, and made a mixture of such strength that 1 c.c. contains 10 milligrammes of the dry substance. With T.R. thus treated, immunity can be acquired without the local or general reaction attendant on the

the use of T.O., or tuberculin. Normal guinea-pigs treated in this manner resist the attacks of virulent tubercle bacilli. The prepared T.R. is used in guinea-pigs when affected with tuberculosis; the tubercular processes in their lesions are said to be either arrested or to recede. Writing of this new T.R., Sims Woodhead* says immunity may be obtained both in lower animals and in man in about three weeks after the administration of 20 mg. has been reached, but in a patient already affected with tuberculosis little curative effect is expected until about a milligramme has been given. Koch says that patients suffering from streptococcal and other complications of mixed infection are not suitable for this treatment, and he insists that wherever the temperature is over 100·4° F. such mixed infections should be diagnosed.

Cases of lupus and pulmonary tuberculosis are stated to have benefited from this treatment, and it would appear from these experiments that under certain conditions an antitoxic, or antibacterial, substance is developed which may be used to combat the disease. Further work must be done before we are in a position to judge of the value of this new tuberculin.

SURGICAL TREATMENT.

There are certain conditions arising in tuberculosis where local operative surgical treatment is required for the removal of the products of the disease. Thus tubercular glands, where accessible, as in the neck, are often most advantageously excised. At the same time, there are many so-called surgical cases of tuberculosis where the open-air treatment may obtain excellent recoveries. "Glands often remaining in evidence for months may disappear; joint affections, if properly treated, do by no

* "The Bacteriology of Tuberculosis," *Practitioner*, June, 1898.

means ill; and the surgeon must decide in relation to each individual case how much or how little is to be expected from natural processes. I would lay stress upon this, because there is no doubt but that glands are now and then removed which would have subsided without operations, and joints occasionally excised which would have recovered if treated by long-continued rest under favourable conditions."* Mr. Treves here gives admirable advice, which, based upon an extensive surgical experience, is of great value in guiding the conduct of a case. Wherever operative surgical procedure is adopted, it is obvious that the eradication of the disease should be as complete as possible, although it is at the same time equally obvious that it never can be absolutely complete. Rest is as essential in surgical as in medical treatment, and is of special importance where joints and bones are affected. Very good results have been obtained by laparotomy in tuberculous peritonitis.† Details as to excision and other operations will be found in text-books on Surgery.

* Treves: "System of Surgery."

† The Harveian Lectures on the Surgical Treatment of Tuberculous Diseases. By Watson Cheyne. *Brit. Med. Journ.*, Dec., 1899.

CHAPTER VIII.

NATIONAL MOVEMENTS AGAINST TUBERCULOSIS.

In Germany — Sanatoria — France — Œuvre de la Tuberculose — Spittoons in Public Schools—Separation of Consumptives in Hospitals from other Patients — Ligue contre la Tuberculose — United States—Board of Health in New York—Practical Measures Adopted —Diminution in Phthisis Rate—Australia—Great Britain—National Association for the Prevention of Tuberculosis.

THE discovery of vaccination by Jenner may be taken to have marked the dawn of a Renaissance age in Medicine. Since then there has been nothing, with the exception of the introduction of antiseptic surgery, fraught with more momentous issues for the welfare of the human race than the discovery by Koch of the tubercle bacillus. From Koch's discovery the knowledge of the means necessary to both the prevention and cure of tuberculosis has arisen. To systematically adopt these means has become a matter of such wide and far-reaching interest that there is scarcely a civilised country to-day which has not, in one form or another, taken public or legislative action to endeavour to combat tuberculosis. A description of all these national movements would far exceed the limits of such a work as this, but not to give some account of the organised efforts to grapple with the disease, which has become a part of the public life of so many civilised countries, would be to omit perhaps the most significant of all the great results which the discovery of the tubercle bacillus has produced. In Germany, France,

the United States, Austria, Russia, Italy, Norway and Sweden, Denmark, Belgium, and many other countries, as well as Australia and other British colonies, steps have been taken, in some cases merely inciting to voluntary effort, in others—especially in the case of Australia—resulting in drastic legislation.

In Germany, perhaps, the most noteworthy and important practical development has been that for the establishment of open-air sanatoria adapted to the requirements and resources of all classes of the community. For this purpose numerous societies have been formed in different parts of Germany. Thus in Berlin there are two influential societies engaged in this work — the Berlin Brandenburg Society, with Professor von Leyden at its head, and the Red Cross Sanatorium Society, under the patronage of Princess Hohenlohe. The Red Cross Sanatorium Society is a branch of the Red Cross Society, which undertakes philanthropic work among the lower classes. A central committee of these various societies was formed in 1896, with the Empress as patron and the Imperial Chancellor as president. This committee publishes a monthly review. The committee is a powerful and influential one, and organised in May, 1899, the famous Congress in Berlin on the "Fight against Tuberculosis as a National Disease." This Congress was attended by delegates from every part of the world, from Japan to Canada, and the honour accorded it marked a red-letter day in the history of science. A more purely scientific body, the German Society of Naturalists and Surgeons, also has a permanent committee for the express purpose of dealing with tuberculosis. More significant than the public movements originating in either science or philanthropy in Germany has been the economical movement for the establish-

ment of sanatoria dictated by the business interests of the large insurance companies. In 1899 an Act was passed making insurance against sickness and old age compulsory on all whose annual income was under £150 per annum. This Act contains a clause allowing any sickness insurance society the discretionary power of devoting a portion of its funds to the treatment of the sick in lieu of sick pay. Over 11,000,000 persons were insured under this Act within two years of its being passed, and it was soon found that half the applications for sick pay between the ages of twenty to twenty-nine were for relief of persons suffering from pulmonary tuberculosis. By the year 1897, thirty-three out of thirty-seven different sickness insurance and friendly societies had spent a portion of their funds on sanatoria for the open-air treatment of consumptives. Gebhard, a director of the Hanseatic Sickness and Old Age Insurance Company, showed that if, out of 500 consumptives, 140 could be restored sufficiently to do without sick pay for a year, this would recoup the company for the cost of treatment in a sanatorium. The Hanseatic Insurance Company now, therefore, possesses sanatoria of its own.*

The experience of large commercial companies thus endorses the teaching of modern medicine, and has largely contributed to the development of the open-air treatment in Germany. If the public interest excited by death statistics is apt to be languid, that aroused by dividends is invariably lively.

In France numerous societies exist for dealing with the prevention and treatment of tuberculosis. Of these the most important are the Œuvre de la Tuberculose, a scientific society which holds periodic

* "Sanatoria for Consumptives." Walters.

congresses and publishes a quarterly journal, *Revue de la Tuberculose.* Of this society Dr. L. H. Petit, himself a well-known writer on Tuberculosis, is the indefatigable secretary-general. An account of the Congress in 1898 has been published, and contains, with numerous interesting papers, a record of the practical results of the third Congress, held in 1893. From this it is evident that the society has taken action in various directions on important public questions connected with the subject. Representations were made by the society to the Ministers of the Interior, Agriculture, Commerce, and Education on many practical points. Thus, the society suggested that all public schools should be provided with spittoons, and that boys should be taught not to spit on the floor or ground, and many inspectors of education and schoolmasters have already acted on these suggestions.

Recommendations dealing with dust, notification of phthisis, disinfection, and hospital treatment were also made; and as a result of the demands made upon public hospitals by the society, a Commission was appointed by the Department for Administering Hospitals, which reported in favour of separating consumptives from the other patients in all public institutions.

The work accomplished by this society is of an extremely interesting and instructive character, and well rewards a full perusal. Enough has, however, been said, to show the lines on which the society has proceeded, and the practical benefit to the public welfare which the unwearying action of such a society as this may obtain. Allied to the Œuvre de la Tuberculose, but of a more popular character, is the "Ligue contre la Tuberculose," and their report of five years' experience, delivered to the Congress in 1898, is extremely interesting. One opinion, strongly

expressed, is that the danger of raising undue alarm by describing tuberculosis as an infectious disease is a much less real one than the difficulty of overcoming prejudice and ignorance and inducing people to adopt rational precautions in the case of the consumptive in private life. The report is too long to consider in detail, but it deals with such practical questions as the use of different forms of spittoons in schools, shops, factories, etc., the disinfection of linen and table utensils, dust, furniture and carpets, and the importance of impressing upon the public that the disease was infectious and not hereditary. The Ligue very justly takes some credit to itself for having been the first of the sort started, from which others have taken example in America, Belgium, Great Britain, and elsewhere.

In the United States of America important steps have been taken by the Board of Health in the City of New York, which, in addition to contributing to the prevention of the actual disease in this huge city, will tend to exercise an educational influence throughout America. An account of their measures is given by Dr. Herman Biggs,* who is director of the bacteriological laboratories in the New York City Department of Health. The measures at present in vogue are so thorough and efficient as to deserve the careful study of all sanitary authorities, and indeed of all educated men interested in the eradication of tuberculosis.

The most important are as follows :—

1. A rigid inspection of animals slaughtered for food and of meat brought into the city has been maintained for many years, and all meat from tuberculous animals is destroyed

2. Strict supervision of milch cows kept within the city limits has been for some time in existence

* *Practitioner*, June, 1898.

and in 1895 the systematic application of the tuberculin test was begun. All animals found to be tuberculous are killed.

3. A special section added to the sanitary code requires the notification of pulmonary tuberculosis as "an infectious and communicable disease . . . dangerous to the public health."

4. Inspection and disinfection, with certain restrictions, are carried out in the private houses of consumptives.

5. Bacteriological examinations of the sputa of consumptives under the care of private practitioners are made in the laboratories of the Department free of charge.

Of the educational influence and value of the measures adopted by the Department Dr. Biggs writes: "The inspectors report a most gratifying increase of intelligence among the better class of the tenement-house population with regard to the true nature of the disease and the usual method of its transmission to others."

The decrease in the death-rate from all tubercular diseases in New York is nothing less than remarkable, as the following table, dealing with the last twelve years, shows, and no impartial reader can withhold from the Health Department a large portion of the credit for this splendid record of human life saved:—

	1886	1887	1888	1889	1890	1891
Death Rate	4·42	4·06	3·99	3·86	3·97	3·56
	1892	1893	1894	1895	1896	1897
Death Rate	3·55	3·51	3·16	3·34	3·06	2·85

In Australia, energetic measures have been taken, and the Acts dealing with tuberculosis among cattle in New South Wales and some of the other Australian colonies are very radical in character.

Thus the one recently passed in West Australia enjoins that milk from tuberculous cows, in any stage of the disease, may not be sold unless boiled for ten minutes and notification to that effect made to the Local Government Board. Also, that "Every medical practitioner attending on, or consulted by, any person suffering from pulmonary tuberculosis shall, so soon as the fact becomes known to him, report the same to the Local Board of the district in which the person resides."

In England two Royal Commissions have been appointed by Parliament, and their work has been extensively referred to in Chapters IV. and VI. More recently an association, under the presidency of H.R.H. the Prince of Wales, was formed, with the title of the "National Association for the Prevention of Consumption and other Forms of Tuberculosis." Their objects and methods have been very similar to those of the "Ligue contre la Tuberculose" in France. In the council and constitution of the association an effort has been successfully made to combine in one body representation of medicine, science, agriculture, and the general public. Various sub-committees to deal with different branches of the subject are appointed, and the work of stimulating public action has been taken thoroughly in hand.

In addition to the central body and council sitting in London, influential branches have been formed throughout the country.

The objects and methods of the Association are described as follows:—

THE NATIONAL ASSOCIATION FOR THE PREVENTION OF CONSUMPTION AND OTHER FORMS OF TUBERCULOSIS.

20, HANOVER SQUARE, LONDON, W.

OBJECT.—The prevention of Tuberculosis.

METHODS.—

I. The education of public opinion and the stimulation of individual initiative by means of—

(*a*) A Central Office for the collection and distribution of information as to modes of diffusion of Tuberculosis and measures of prevention.

(*b*) The circulation of pamphlets and leaflets setting forth in plain language the results of scientific investigation of the above points.

(*c*) Public Lectures by men approved by the Council; Addresses at Congresses and other public gatherings.

(*d*) Co-operation with other societies having for their object the promotion of public health.

(*e*) The co-operation of the public press.

(*f*) Periodical Congresses and the issue of an Annual Report.

(*g*) The promotion of the establishment of open-air Sanatoria for tuberculous patients.

II. The influencing of Parliament, County Councils, Boards of Guardians, Chambers of Agriculture, and other Public Authorities on matters relating to the Prevention of Tuberculosis.

III. The establishment throughout the kingdom of local Branches of the Association, which are affiliated with the Central Office. Secretaries of Branches are supplied with all literature at cost price.

The leaflets of the Association have been widely distributed. They deal in simple and forcible language with some of the precautions necessary for the prevention of tuberculosis, and some of those already published will be found in the Appendix.

Attention in England is now gradually being aroused and public interest stimulated; and it is to be hoped before long that decided action for the more direct prevention of tuberculosis will be instituted.

APPENDIX.

1. "How to Prevent Consumption." } *Leaflets published by the National Association for the Prevention of Tuberculosis.*
2. "Fresh Air and Ventilation." }
3. Rules of Victoria Hospital, Edinburgh.
4. Tuberculin Test in Cattle.
5. Recommendations of the Second Royal Commission on Tuberculosis.

1. How to Prevent Consumption.

Consumption (with other forms of tuberculosis) causes one death in every eight in this country. Of all deaths in the United Kingdom between the ages of twenty-five and thirty-five *nearly one-half are due to consumption.*

It gives rise to a vast amount of suffering and permanent ill-health. It is calculated that in Great Britain at the present moment at least a quarter of a million persons are suffering from it.

The disease is preventable.

Its predisposing cause is a low state of health, such as may be inherited, or may be induced by overcrowding; the stuffy air of ill-ventilated rooms; dirty, dark, and damp dwellings; bad or insufficient food; intemperance; and infectious fevers, or other illnesses.

Consumption is, however, contracted by taking into the system the germ or microbe of the disease, either in the dust of the air, or in food and drink (principally unboiled milk).

These germs are only derived from persons or animals already suffering from consumption, or some other form of tuberculosis. They are found in vast numbers in the phlegm, spit, or expectoration of a consumptive person.

In a moist state this expectoration does not infect the air, but if allowed to dry and become dust it is exceedingly dangerous, and is then the chief means by which the disease is spread from person to person.

There is practically no risk of contracting the disease from the breath of a consumptive person.

There is no objection to a consumptive invalid being closely attended upon by healthy persons, who may also share the same bedroom, though not the same bed.

Precautions.—The spit of the consumptive being the chief cause of the spread of consumption, it is essential for the protection of their own families, and to prevent the spread of the disease among the general public, that the following simple precautions be taken by consumptive persons :—

The consumptive person must not expectorate about the house, nor on the floor of any cab, omnibus, tram-car, railway carriage, or other conveyance. Spitting about the streets, or in any public buildings (churches, schools, theatres, railway stations, etc.), is a dangerous as well as a filthy habit.

The consumptive person must not expectorate anywhere except into a special vessel or cup kept for the purpose, and containing a little water.

When out of doors, a small, wide-mouthed bottle with a well-fitting cork, or a pocket spittoon, which may be obtained from any chemist, should be used.

The spit or expectoration must be carefully burnt in the fire, at least once daily ; this is the simplest, quickest, and safest way of destroying the germs it contains.

When there is no fire, the expectoration may be washed into the drain or buried in the earth.

The cup and spittoon must then be kept in boiling water for ten minutes before being thoroughly cleaned.

When not provided with a proper vessel, a consumptive person must not spit into a handkerchief, but into a piece of rag or paper, which must be burnt.

Consumptive persons must not swallow their phlegm, as, by so doing, the disease may be conveyed to parts of the body not already affected.

A consumptive person must not kiss, or be kissed, on the mouth.

General Precautions to be Observed :—

All rooms occupied by consumptive persons should be as free from damp, and as well lighted and ventilated as possible. Fresh air, light, and sunshine are most important preventives of consumption. Overcrowding should be avoided.

No chimney should ever be blocked up, and windows should be kept open as much as possible.

Cleanliness and good sanitary surroundings are important, both for the prevention and for the cure of consumption.

Rooms, passages, and staircases must be kept free from dust. Where there is dust there is danger. Do not chase dust about, or stir it up. Use damp dusters. Use plenty of tea-leaves, or damp sawdust, for sweeping up the floor. Boil the dusters ; burn the tea-leaves and sawdust.

Milk, especially that used for children and invalids, should be boiled or sterilised. Meat should be well cooked.

In the event of a death from consumption the room occupied by the invalid should not be used again until it has been thoroughly cleansed ; advice may be sought from the local sanitary authority.

2. Fresh Air and Ventilation.

Ventilation by means of fresh air is most important for the preservation of health. This applies to children as much as to adults.

Want of proper ventilation predisposes to various forms of disease, especially to consumption and other forms of tuberculosis, by bringing about a low state of health.

In order to prevent the development and the spread of consumption, fresh air and proper ventilation are essential in factories, workshops and offices, particularly where the work carried on is associated with gaseous fumes or fine dust.

The better the ventilation, the greater the worker's power.

The breath from the lungs contains foul organic matter which is highly poisonous.

The air containing this foul organic matter must be quickly removed from living- and sleeping-rooms, and also from workrooms, schools, churches, places of entertainment, public vehicles, etc.

If not removed by efficient ventilation, the foul air is breathed again and again, and so poisons the blood.

This is a common cause of headache, nausea, loss of appetite, lassitude, anæmia, poorness of blood, and chronic ill-health, predisposing to consumption and other diseases.

Overcrowding is dangerous and injurious to health wherever it occurs, and should therefore be avoided.

When a room, on entering it directly from the open air, smells close and stuffy, the foul air it contains is not fit to breathe, and more fresh air is required.

Windows should be made to open to the external air, and should be kept open day and night, unless this is forbidden by the medical adviser.

A free supply of fresh air is secured by widely opening the window at the top, or by opening the bottom sash about four

inches, and inserting between the window-frame and the sill a piece of wood the whole width of the window, so that the air enters, in the former case, at the top of the room, in the latter case, between the sashes at the middle of the window, and in an upward direction.

Open spaces around buildings are necessary to allow access of fresh air.

Back-to-back houses and cellar tenements are unfit for human habitation.

Fresh air and sunlight kill disease germs. Every room in which there has been a case of infectious disease must be specially well ventilated.

Every room, especially if used for sleeping in, should have an open fireplace.

Never block up the fireplace or the chimney. If there be a register, never close it.

Rooms — especially bedrooms — staircases, and passages should be frequently flooded with fresh air by opening all the windows and doors. This is particularly necessary after crowded gatherings in churches, schoolrooms, hotels, theatres, public halls, etc.

The air of a room can never be pure if the room be dirty.

Remember that the air of rooms is rendered impure by burning in them gas or oil for lighting, heating, or cooking.

3. Rules for Consumptive Patients and those looking after them.

(*Arranged for the Victoria Hospital for Consumption, Edinburgh, 1st January*, 1891.)

Consumption is a communicable disease. It may pass from person to person. It may pass from one lung to the other, or from one organ to another.

The chief source of infection is the expectoration of the consumptive. The great danger lies in the drying of the expectoration, and the blowing about of the dried infectious material.

The spread of consumption can be largely prevented. *If the succeeding directions be obeyed, there need be no serious danger in ordinary intercourse with patients. The breath of the consumptive is not directly infectious.*

The patient should expectorate into a jar or cup containing a tablespoonful of carbolic acid (1 to 20) or other disinfectant.

The vessel should be changed once in twelve hours, or oftener. It should be cleansed by being filled up with *boiling* water. The combined contents should be poured down the

water-closet. The vessel should then be washed with *boiling* water.

When the patient is out of doors, he should carry a pocket spitting flask (such as Dettweiler's, or the Victoria Hospital simpler model).* The flask should be used and cleansed like the jar. The patient should never spit on the streets.

The patient should not use handkerchiefs for expectoration. If this ever has to be done, the handkerchief should be of an inexpensive material, that it may be burned after use. Squares of rag or paper, which may be used for convenience, should be similarly treated.

The expectoration should on no account be swallowed, for thereby the disease may pass to other organs.

Consumptive patients should avoid kissing.

Consumptive mothers should not suckle.

If expectoration has been accidentally deposited on the floor or other object, it should be wiped up and burned, and the surface of the object cleansed with strong disinfectant.

Rooms which have been long occupied by a consumptive patient should, before occupation by someone else, be carefully disinfected, as after other infectious disease.

Fresh Air is the food of the lungs. Therefore, see that the lungs be not starved.

(*A*) By Day.—The patient should occupy as airy a room as possible. It must be scrupulously dry, and preferably removed from the ground. The window should be freely open. When able, the patient should be out of doors once or several times during the day. He must avoid over-effort, and damp, or chill, which would counteract the benefit.

(*B*) By Night.—He should sleep alone. The bedroom should be large and airy. The window should be kept open, less or more according to the season.

4. Tuberculin Test.

The following directions are quoted by Knopf,† and are those issued by Professor Leonard Pearson, the State veterinarian of the State of Pennsylvania:—

Directions for Inspecting Herds for Tuberculosis.

"Inspection should be carried on while the herd is stabled. If it is necessary to stable animals under unusual conditions

* See Baildon's sputum bottle, p. 128.

† "Prophylaxis and Treatment of Pulmonary Tuberculosis." S. A. Knopf.

or among unusual surroundings that make them uneasy and excited, the tuberculin test should be postponed until the cattle have become accustomed to the conditions they are subjected to, and then begin with a careful physical examination of each animal. This is essential, because in some severe cases of tuberculosis no reaction follows the injection of tuberculin, but experience has shown that these cases can be discovered by physical examination. This examination should be complete, and include a careful examination of the udder and of the superficial lymphatic glands and auscultation of the lungs.

"Each animal should be numbered or described in such a way that it can be recognised without difficulty. It is well to number the stalls with chalk, and transfer these numbers to the temperature sheet, so that the temperature of each animal can be recorded in its appropriate place without danger of confusion. The following procedure has been used extensively, and has given excellent results :—

"(*a*) Take the temperature of each animal to be tested at least twice, at intervals of three hours, before tuberculin is injected.

"(*b*) Inject the tuberculin* in the evening, preferably between the hours of six and nine. The injection should be made with a carefully sterilised hypodermic syringe. The most convenient point for injection is back of the left scapula. Prior to the injection the skin should be washed carefully with a 5 per cent. solution of creoline or other antiseptic.

"(*c*) The temperature should be taken nine hours after the injection, and temperature measurements repeated at regular intervals of two or three hours until the sixteenth hour after the injection.

"(*d*) When there is no elevation of temperature at this time (sixteen hours after injection), the examination may be discontinued ; but if the temperature shows an upward tendency, measurements must be continued until a distinct reaction is recognised, or until the temperature begins to fall.

"(*e*) If a reaction is detected prior to the sixteenth hour, the measurements of temperature should be continued until the expiration of this period.

"(*f*) The thermometers used for this work should be

* Average dose, 0·25 c.c. In diluting for an injection, a 10 per cent. solution of tuberculin is made by adding 9 parts of a 1 per cent. solution of ac. carbol.

accurate, and if several are used they should be compared before the examination is commenced.

"(*g*) If there is an unusual change of temperature of the stable, or a sudden change of weather, this fact should be recorded on the report-blank.

" *h*) If a cow is in a febrile condition when the initial temperatures are taken, tuberculin should not be used on her, because in this case the temperature curve is irregular and the result of the test uncertain.

" *i*) Cows should not be tested within a few days before or after calving, for experience has shown that the result at these times may be misleading.

"(*j*) The tuberculin test is not recommended for calves under three months old.

"(*k*) In old, emaciated animals or retests use twice the usual dose of tuberculin.

"In reporting upon the examination of the herd, the large temperature sheets should be filled out and returned, together with a more detailed record for each animal that proves to be tuberculous. This detailed report should be made out on the individual report-blanks provided for this purpose.

"Condemned cattle must be removed from the herd and kept away from those that are healthy.

"In special cases inspectors may be directed to destroy and make post-mortem examinations upon the condemned animals as soon as they are recognised, but this must only be done when directions to this effect are given in the original letter of advice.

"In making post-mortems the carcases should be thoroughly inspected, and all of the organs mentioned on the blank for reporting this work should be examined."

In England the dose used is somewhat larger, and the following simple practical directions for using tuberculin are issued by the Royal Veterinary College, London.

1. While under the tuberculin test cattle ought to be kept in the house, fed on their usual food, and protected from draughts. They ought not to be allowed to drink large quantities of cold water between the sixth and fifteenth hours after injection. It is well to take their temperatures at least once on the day preceding the test.
2. The dose of tuberculin for a medium-sized cow is 3 cubic centimetres, or 50 minims, and it may be varied above or below that according to the size of the animal. Large bulls ought to receive 4 cc.

3. It ought to be injected under the skin with a clean hypodermic syringe. The most convenient points are in front of the shoulder, or on the chest wall behind the point of the elbow. The best form of syringe is one with an asbestos piston, as the whole instrument may be sterilised by boiling it in water for five minutes before use.
4. The tuberculin must be injected into the subcutaneous connective tissue, and care must be taken that the whole dose is introduced.
5. The temperature must be taken at the time of injection, and at the ninth, twelfth, and fifteenth hours afterwards
6. Animals in which the temperature during the fifteen hours following the injection rises *gradually* to 104° or more may be classed as *tuberculous*, and those in which it remains under 103° as *not tuberculous*. When the maximum temperature attained is under 104° but over 103° the case must be considered doubtful, and the animal may be re-tested after a month.
7. This test is not reliable in the case of animals in the last stage of the disease, or in those in which the temperature is over 103° before injection.
8. The tuberculin should be kept in a cool place, and protected from light. Should it become turbid or cloudy it must not be used.
9. The tuberculin test does not render the milk in any way injurious.

The report issued by Professor McFadyean for 1898 gives further interesting information with regard to the test.*

5. Recommendations of the Second Royal Commission on Tuberculosis.

Meat.

A.—Slaughter-houses.

1. We recommend that in all towns and municipal boroughs in England and Wales, and in Ireland, powers be conferred on the authorities similar to those conferred on Scottish corporations and municipalities by the Burgh Police (Scotland) Act, 1892, viz. :—

(*a*) When the local authority in any town or urban district in England and Wales and Ireland have

* Annual Report for 1898 from the Principal of the Royal Veterinary College.

provided a public slaughter-house power be conferred on them to declare that no other place within the town or borough shall be used for slaughtering, except that a period of three years be allowed to the owners of existing registered private slaughter-houses to apply their premises to other purposes. The term of three years to date, in those places where adequate public slaughter-houses already exist, from the public announcement by the local authority that the use of such public slaughter-houses is obligatory, or, in those places where public slaughter-houses have not been erected, from the public announcement by the local authority that tenders for their erection have been accepted.

(*b*) That local authorities be empowered to require all meat slaughtered elsewhere than in a public slaughter-house, and brought into the district for sale, to be taken to a place or places where such meat may be inspected; and that local authorities be empowered to make a charge to cover the reasonable expenses attendant on such inspection.

(*c*) That when a public slaughter-house has been established, inspectors shall be engaged to inspect all animals immediately after slaughter, and stamp the joints of all carcases passed as sound.

2. It appears desirable that in London the provision of public in substitution for private slaughter-houses should be considered in respect to the needs of London as a whole, and in determining their positions regard must be had for the convenient conveyance of animals by railway from the market beyond the limits of London, as well as from the Islington market, to the public slaughter-houses which should be provided. At the present time no administrative authority has statutory power authorising it to provide public slaughter-houses other than for the slaughter of foreign cattle at the port of debarkation.

3. With regard to slaughter-houses in rural districts, the case is not so easy to deal with. But the difficulty is one that must be faced, otherwise there will be a dangerous tendency to send unwholesome animals to be slaughtered and sold in small villages where they will escape inspection. We recommend, therefore, that in Great Britain the inspection of meat in rural districts be administered by the county councils. In Ireland the duty of carrying out inspection ought to devolve upon authorities corresponding as nearly as possible to those

charged with that duty in England and Scotland. In view of the announced intention of the Government to introduce a new scheme of local government into Ireland we refrain from specifying the exact machinery which should be employed.

4. We recommend further that it shall not be lawful to offer for sale the meat of any animal which has not been killed in a duly licensed slaughter-house.

B.—Qualification of Meat Inspectors.

5. We recommend that in future no person be permitted to act as a meat inspector until he has passed a qualifying examination, before such authority as may be prescribed by the Local Government Board (or Board of Agriculture), on the following subjects :—

(*a*) The law of meat inspection, and such byelaws, regulations, etc., as may be in force at the time he presents himself for examination.

(*b*) The names and situations of the organs of the body.

(*c*) Signs of health and disease in animals destined for food, both when alive and after slaughter.

(*d*) The appearance and character of fresh meat, organs, fat, and blood, and the conditions rendering them, or preparations from them, fit or unfit for human food.

C.—Tuberculosis in Animals intended for Food.

6. We recommend that the Local Government Board be empowered to issue instructions from time to time for the guidance of meat inspectors, prescribing the degree of tubercular disease which, in the opinion of the Board, should cause a carcase, or part thereof, to be seized.

Pending the issue of such instructions we are of opinion that the following principles should be observed in the inspection of tuberculous carcases of cattle :—

(*a*) When there is miliary tuberculosis of both lungs	The entire carcase and all the organs may be seized.
(*b*) When tuberculous lesions are present on the pleura and peritoneum	
(*c*) When tuberculous lesions are present on the muscular system, or in the lymphatic glands embedded in or between the muscles	
(*d*) When tuberculous lesions exist in any part of an emaciated carcase	

(*a*) When the lesions are confined to the lungs and the thoracic lymphatic glands	The carcase, if otherwise healthy, shall not be condemned, but every part of it containing tuberculous lesions shall be seized.
(*b*) When the lesions are confined to the liver	
(*c*) When the lesions are confined to the pharyngeal lymphatic glands	
(*d*) When the lesions are confined to any combination of the foregoing, but are collectively small in extent	

In view of the greater tendency to generalisation of tuberculosis in the pig, we consider that the presence of tubercular deposit in any degree should involve seizure of the whole carcase and of the organs.

In respect of foreign dead meat, seizure shall ensue in every case where the pleura have been "stripped."

Milk.

D.—Diseases in the Udders of Cows.

7. We recommend that notification of every disease in the udder shall be made compulsory, under penalty, on the owners of all cows, whether in private dairies or those of which the milk is offered for sale.

8. We recommend that for the purpose of excluding from their districts the milk of cows affected with tuberculosis of the udder, or exhibiting clinical symptoms of the disease, local authorities should be given powers somewhat similar to those of sections 24—27 of the Glasgow Police (Amendment) Act, with power to slaughter such cows subject to compensation under the conditions named in the Report.

9. We also recommend that powers shall be given to local authorities to take samples and make analyses from time to time of the milk produced or sold in their districts, and that milk vendors shall be required to supply sufficient information as to the sources from which their milk is derived.

At ports where milk and milk products are received from foreign countries, any costs that may be thus incurred in their examination shall be born by the importers.

E.—Cowsheds, Byres, etc.

10. We recommend that the Local Government Board be empowered to require local authorities to adopt regulations as

to dairies, cowsheds, etc., where that shall be found not to have been done already.

11. That in future no cowshed, byre, or shippon, other than those already registered, shall be permitted or registered in urban districts within 100 feet of any dwelling-house; and that the discontinuance of any one already existing shall be ordered on the certificate, either of the medical officer of health that it is injurious to the health of human beings residing near it, or of the veterinary inspector that it is not a place wherein cows ought to be kept for the purpose of milk supply, and that it is incapable of being made so.

12. That the conditions of the attached cowsheds that shall warrant the registering of a dairy in a populous place, whether technically urban or rural, in the future shall include the following :—

1. An impervious floor.
2. A sufficient water supply for flushing.
3. Proper drainage.
4. A *depôt* for the manure at a sufficient distance from the byres.
5. A minimum cubic contents as regards such districts of from 600 to 800 feet for each adult beast varying according to the average weight of the animals.
6. A minimum floor space of 50 feet to each adult beast.
7. Sufficient light and ventilation.

While we have prescribed a minimum cubic contents and floor space without mentioning definite dimensions affecting ventilation and lighting, we are distinctly of opinion that these are by far the most important, and that requirements as to cubic and floor space are mainly of value as tending to facilitate adequate movement of air.

Existing cowsheds should be obliged to conform to the prescribed regulations within a period of twelve months from the time of the regulations coming into force.

13. The same conditions as those recommended for populous places should apply to cowsheds in sparsely populated places, except in so far as cubic contents per cow are concerned; as regards these cubic contents, such space per cow should be provided as would, in view of the surrounding circumstances, secure reasonable ventilation without draught. But the physical circumstances prevailing in different localities being so various, we do not find it practicable to prescribe uniform minimum requirements in this respect.

14. We recommend that where cows housed in one district supply milk to another district, the local authority of the

district in which the cows are housed shall be bound, when required, to supply to the local authority of the district in which the milk is sold or consumed full information and veterinary reports regarding the condition of the cows, byres, etc., whence the milk is drawn. Where the local authority of one district are dissatisfied with the reports so obtained, they may apply to the Local Government Board, with a view to an independent inspection and report being made.

F.—Elimination of Bovine Tuberculosis.

15. We recommend that funds be placed at the disposal of the Board of Agriculture in England and Scotland, and of the Veterinary Department of the Privy Council in Ireland, for the preparation of commercial tuberculin, and that stock-owners be encouraged to test their animals by the offer of a gratuitous supply of tuberculin and the gratuitous services of a veterinary surgeon on certain conditions.

These conditions shall be—

(*a*) That the test be applied by a veterinary surgeon.

(*b*) That tuberculin be supplied only to such owners as will undertake to isolate reacting animals from healthy ones.

(*c*) That the stock to be tested shall be kept under satisfactory sanitary conditions, and more especially that sufficient air space, ventilation, and light be provided in the buildings occupied by the animals.

16. We recommend that the Board of Agriculture in England and Scotland and the Veterinary Department of the Privy Council in Ireland undertake the circulation among agricultural societies of instruction for the proper use of the tuberculin test, with explanation of the significance of reaction, and directions for effective isolation of reacting animals.

The Commission desire to place on record their sense of the services rendered by their Secretary, Mr. T. M. Legge, whose professional knowledge has rendered him of great assistance in the inquiry, while his acquaintance with French and German has enabled him to translate for the use of the Commission a large number of valuable reports, returns, and other documents in these languages, and to conduct an extensive correspondence with continental authorities.

INDEX.

Abattoirs, Continental, 135
Abscess, Tubercular, Cold, 72
Achtermann, 183
Action of pure air on consumption, 163
Acute tuberculosis, 24
Adenoid growths, 31, 89, 110
Adirondacks, 184
Age, Influence of, 19
Air Fresh, 227
——, Sewage, 165
Airing of cities, 156
Albertsberg sanatorium, 195, 197
Alimentary system, Tubercle of, 63
—— —— in phthisis, 49
Allbutt, Clifford, 158
Altitudes, High, 18, 166, 179
Anatomists' tubercle, 76
Anthracosis, 55
Ape, Tuberculosis in, 95
Appetite in phthisis, 197
Arthaud, 84
Asthma, 57
Ascot, 190
Athens death rate, 18
Atmospheric impurity, 122
Auscultation, 53
Australia Health Acts, 123, 148–223
Auxiliary forces of invasion, 88
Avian tuberculosis, 9, 102

Bacillus. See Tubercle bacillus
Back-to-back houses, 229
Bang of Denmark, 119, 132
Baumgarten, 20, 79
Bedroom ventilation, 173–5, 182, 196
Beevor, Sir Hugh, 16, 139
Belfast, Meat inspection in, 133
Bennett, Henry, 167, 175
Berlin Brandenberg Society, 218
Bert, Paul, 165
Berthenson, 175
Biggs, Herman, 151, 221
Birch-Hirschfeld, 11, 41, 56
Bladder, Tubercle of, 67
Bovine tuberculosis, Elimination of, 142, 237
Bowditch, 124
Boyd, Stanley, 7
Brain, Tubercle of, 62
Breath of consumptives, 91
Brehmer, 183, 192
—— sanatorium, 191
British sanatoria, 189
Broadbent, Sir William, 5, 32, 144
Bronchial lymphadenitis, 35
Bronchiectasis, 57
Bronchitis, 57, 89
Broncho-pneumonic phthisis, 37
Bronchophany, 54
Brown, Sir George, 141.
Brown-Séquard, 166
Bruce-Mitchell, 178
Buchanan, 123
Butter, 107, 119
—— Milk, 117

Cabin accommodation, 176
Cadeot, 103
Calcification, 22, 40
Caries, 71
Carious teeth, 89
Caseation, 22
Caseous tuberculosis of lungs, 36
Catarrh, 90, 163
Cavities in phthisis, 42
Cellar tenements, 229
Cervical lymphadenitis, 31
Chalmers Kerr, 122, 140, 154
Channels of spreading within host, 11
Cheese, 108, 119
Cheyne, Watson, 7, 216
Children, Care of, 125–6
Chimneys, 229
Christiana death rate, 18
Chronic phthisis, 38
Cicatrisation, 22
Classification of clinical forms, 23
Clinical form of disease, 23
Climate, 18, 179
Coghill, 208
Columella, 4
Cold abscess, 72

Communicability of tuberculosis, 2, 82, 105
Compensation for condemned meat, 135
Congenital tuberculosis, 24, 79
Consumption, 34
Congress, French, 220
——, Berlin, 218
Contagion, 2
Contagious Diseases (Animals) Act, 138
Cooking, effect tuberculous meat, 99
Cowsheds, 235
Cornet, 12, 81
Cough in phthisis, 44, 208
Cream, 108, 117
Cromer, 193
Crookshank, 214

Damp, 85, 124
Dairies, Cowsheds, etc., Order, 137
Daremberg, 84, 165, 198
Darkness, Influence of, 85, 116
D'Arsonval, 166
Davos, 168, 194
De Thoma, 84
Death rate, 18, 19
Deck chair, 168
Denmark butter, 119
Dettweiler, 184, 195, 197
Devonshire butter, 119
Diarrhœa, 49, 209
Disposal of sputa, 113
Disinfection, 150
Döcker huts, 187, 188
Doss houses, 154, 155
Draughts, 173
Dress for children, 125, 126
Dryness, 116
Dublin, meat inspection, 133
Dust, 112, 228
—— pneumonia, 112
Dyspepsia, 209
Dyspnœa in phthisis, 46

Education of children, 125
Educational influence of sanatoria, 187
Egypt, 181
Elastic tissue in sputum, 45
Emphysema compensatory, 40
England and Wales, Health Acts, 133, 137
Epithelioid cells, 8
Etiology of tuberculosis, 6–13
Exercise in phthisis, 199
Exhalations from lungs, 167
Experiments with tuberculous meat, 96, 100
—— —— milk, 103
Eye, Tuberculous disease of, 78

Factory Acts, 153
Falkenstein sanatorium, 181, 183
Fallopian tubes, 69
Fanning, Burton, 189
Fever in phthisis, 39, 47, 198, 205
—— in tuberculosis, 215
Fevers, Specific, 90
Fibro-caseous phthisis, 39
Fibroid phthisis, 55
Fistula in ano, 65
Flügge on vacuoles, 12
Fog, 173
Food, Experiments on animals, 96, 100, 103
Food in phthisis, 197, 201
Fowler, Kingston, 34, 39, 42
Fox, Wilson, 206
France, 219

Galtier, 119
Ganglion, Compound, 73
——, Simple, 76
Gasperini, 119
Gavarret, 166
Gebhard, 219
Genito-urinary system, Tubercle in, 66
Geographical distribution, 17
Germany, 218
Giant cells, 8, 21
Gilbert, 103
Glasgow Health Act, 136, 139
Glanders, 128
Görbersdorf, 183
Gosse, 105
Grabowsee, 187
Granulomata, 3, 212
Gwynn, 190

Hæmopoietic system in phthisis, 49
Hæmoptysis, 46, 57, 206
Hammond, 166
Hanseatic Insurance Company, 219
Harben lectures, 149
Haviland, 124
Health in the house, 114
Hein, 119
Heredity, 79, 98
Herroun, 214
Hess, 184
High altitudes, 166
Histology, 20
Holmboe, 151
Housing of Working Classes Act, 152, 153
Hunter, 214
Hutchinson, Jonathan, 77

Infant mortality, 106
Infection, 2
Ingestion of tubercle bacilli, 86
Inhalation of tubercle bacilli, 83, 88
——, Antiseptic, 208
Inherited susceptibility, 80
Inoculation, 77, 78, 87
Inspection in phthisis, 52
Inspection of meat, 132
Insurance by cattle owners, 135

Insurance companies' action in Germany, 218
Integumentary system, 76
Intestines, Tubercle of, 64
Invasion, Paths of, 86, 109
Isolation of consumptives, 152
Isolation of tuberculous cattle, 142
Italian law on infection, 5

Jersey, Infant mortality in, 106
Jersey, Bovine tuberculosis in, 107, 160
Joints, Tuberculosis of, 69

Kaffir, Tuberculosis in, 95
Kidd, Percy, 42
Kidneys, Tubercle in, 66
Kimberley Sanatorium, 174, 180
Klebs, 214
Klencke, 5
Knopf, 87
Koch, Discovery of, 5
——, Bacillus of, 5
—— on sputum, 83
—— researches on etiology, 6-13
—— researches with tuberculin, 210–215
Kühne, 214

Laennec, 158
Latent tubercle, 79
Latitude, effect on tuberculosis, 18
Leaflets, National Association for Prevention of Tuberculosis, 225–6
Leblanc, 165
Liegehalle, 171, 183
Light, Influence of, 85, 116
Ligue contre la Tuberculose, 220
Lima death rate, 18
Lindemann, 87
Lips, Tubercle of, 63
Littlejohn, Sir H., 121
Liver, Tubercle in, 21
Lombard on death rates, 18
London death rate, 18
—— Health Act, 133
—— open-air sanatorium, 190, 195
—— slaughter-houses, 235
Loomis, 158
Lupus vulgaris, 77
Lymph glands, 29
Lymphadenitis, Bronchial, 33
——, Cervical, 31
——, General, 30
——, Mesenteric, 32

Mcfadyean, Prof., 132, 137, 146, 232
Macfadyen, 119
Malaria, 90
Mammary gland, Tubercle in, 66
Manasse, 191
Manchester, Meat inspection in, 134
Maragliano, 214
Marfan, 30, 84[1]
Marmot, inoculated with avian tubercle bacilli, 9
Martin, H., 102
——, Sidney, 96, 99, 103, 140, 145
Meals in sanatoria, 197
Meat inspection, 132, 234
—— inspectors, 133, 234
—— juice, raw, 102
—— rolls, 98, 100, 120
——, Tuberculous, 97
Metchinkoff on phagocytosis, 9
Micrococci septic, 167
Milan, Death rate in, 18
Miliary tuberculosis, 24
—— —— of lungs, 25
Milk cows, Tuberculous, 103, 105, 108, 117, 136, 235
——, cooked, 118
—— from reacting cows, 147
—— Order, 1899, 131
—— products, 107
Mistral in the Riviera, 169
Mixed infection in phthisis, 39
—— —— in tubercular abscess, 73
Morbid anatomy of phthisis, 40
Morris, Malcolm, 77, 152
Mortality from tuberculosis, 1
Mosso, 166
Muir, 213

Nansen, 151
National Association for Prevention of Tuberculosis, 153, 223
National movements against tuberculosis, 217
Navy, French, Phthisis in, 178
Newsholme, 152
Newman, 10
New York, 221
Nightingale, Florence, 173
Nocard, 4, 83, 98, 160
Nordrach Sanatorium, Black Forest, 181
—— -upon-Mendip, 190
Norfolk, 189
Norway, 151
Notification of phthisis, 148, 153
—— of udder disease, 141

Ocean voyages, 176
Œuvre de la tuberculose, 219
Oertel, 166
Œsophagus, Tubercle of, 63
Open-air treatment, 159
—— —— in a private house, 202
Orienbäd, 187
Osler, 48, 158

Palate, Tubercle of, 63
Paris, Old quarters of, 154
Pasteurisation, 108, 119
Paths of invasion, 109
Pectoriloquy, 54
Pericardium, 62
Periostitis, Tubercular, 72

Peritonitis, Tubercular, 59
Peter Michel, 182
Petit, L. H., 220
Pettenkoffer, 166
Pfeiffer on Mixed Infection, 40
Phagocytosis, 9
Philip, R. W., of Edinburgh, 152, 189
Phthisis, 34
——, Acute pneumonic, 36
——, —— broncho-pneumonic, 37
——, Alimentary system in, 49
——, Chronic, 38
——, Circulatory system in, 50
—— cough, 208
——, Diarrhœa in, 209
——, Diet in, 197, 201
——, Dyspepsia in, 209
——, Establishment of, 44
—— emaciation, 48
——, Fever in, 39, 47, 205
—— Fibro-caseous, 38
——, Fibroid, 55
——, Genito-urinary system in, 50
——, Hæmoptysis in, 46, 206
——, Incidence of, locally, map, 139
—— in public hospitals, 220
——, Integumentary system in, 50
——, Locomotory system in, 51
——, Mixed infection in, 39
——, Nervous system in, 51
——, Notification of, 148
——, Onset of, 44
——, Pain in, 46, 207
——, Physical signs in, 51
——, Pyrexia in, 39, 47, 205
——, Pulse in, 48
——, Sweating in, 48
——, Symptoms of, 44
Pig, Tuberculosis in, 102
Pleurisy, Tubercular, 61
Pneumococcus, 16, 112
Pneumothorax, 48
Pocket spittoons, 128, 199, 204
Precautions with consumptive, 127, 226
Prevention of tuberculosis in every-day life, 111, 226
—— —— by legislation and public action, 130
—— —— in New York, 221
Public Health Acts, 133, 138
Pulmonary tuberculosis, 34
Pyopneumothorax, 49

Rabinowitsch, 107
Race, Influence of, 18
Railway carriages, 113
Rain, 171
Ransome, A., 85, 87, 123
Rationale of open-air treatment, 161
Recommendations of Royal Commission, 143, 234
Red Cross sanatorium, Germany, 187
—— —— Society, Germany, 187, 218
Rehburg Sanatorium, 191
Reiset, 166
Respiratory, Impurity of air, 122, 165
Rest, 196
Results of sanatorium treatment, 191 193
Revue de la Tuberculose, 220
Rio Janeiro death rate, 18
Riviera, 167, 169
Roget, 103
Rowton Houses, 154
Royal Commission, First, 96
—— ——, Second, 100
Rules for patients, 229
Russia, 168

Sanatoria for consumption, 180
——, Requirements in, 194
——, Treatment in, 195
——, Results in, 190, 193
——, British, 189
——, German, 181
Schools, Spitting in, 128, 220
Sclerosis, 22
Scrofula, 29, 31, 110
Sea voyages, 176
Secondary inflammatory processes, 23
Septic infection in phthisis, 39
Sheep, 102
Sheffield meat inspection, 134
Ship life, 176
Silicosis, 55
Slaughter-houses, 98, 134, 232
Smeared meat, 99
Soil, Influence of, 123
Sources of danger, 111
South Africa, 171, 179, 180, 18
Spain, 4, 5
Spencer, Herbert, 125
Spinal cord, Tubercle of, 62
Spitting, 128, 226
Spittoons, Pocket, 128, 199, 204
Spontaneous healing in phthisis, 157
Spores, 12
Sputum, Examination of, 15, 83, 85, 127
Staining, Tubercle bacilli, 15
Staphylococcus, 39
Statistics, Influence of soil, 123
——, Tuberculosis, 1, 139
——, Spontaneous healing in phthisis, 158
——, Tuberculous food animals, 97
——, Mortality tables, 106
—— from the Morgue, Paris, 15
——, Results in sanatoria, 190, 193
Sterilisation of milk, 108
Stomach, Tubercle of, 63
St. Petersburg, 18, 175
Straus, 84, 102
Streptococcus, 39
Sunshine, 85, 114, 196, 228
Surgical treatment, 215

Susceptibility to tuberculosis, 120
—— ——, Inherited, 121
—— ——, Acquired, 121
Sweating in phthisis, 208

Tabes mesenterica, 32
Tappeiner, 83.
Tatham, 106, 213
Teeth, Carious, 89
Teno-synovitis, Tubercular, 73
Testis, Tubercle of, 68
Thaon, 83
Thorne Thorne, Sir R., 32, 106, 117, 149
Thurnam, 190, 192
Tongue, Tubercle of, 63
Tonsils, 33, 63, 109
Toxic exhalation, 167
—— effect of dead tubercle bacilli, 13
Trade winds, 69
Training ships, Phthisis in, 178
Trauma, 91
Treatment, 157
—— in sanatoria, 195
—— in a private house, 202
—— in general and special hospitals, 203
Treves, 216
Trudeau, 3, 160
Tubercle bacillus, 13, 14
—— —— life outside host, 16
—— ——, Aberrant forms of, 14
—— ——, Mounting and staining, 15
Tubercular meningitis, 26
—— nodule, 10, 20
Tuberculin, 210
—— as a test in cattle, 132, 230
Tuberculosis, Definition of, 3
——, National movements against, 217.
—— in animals, 6, 234

Udder disease, 141, 235
—— ——, Notification of, 144, 235
Ulcer, Tubercular, 76
United States health legislation, 148, 221
Ureters, Tubercle in, 67
Urine, Tuberculous, 67
Uterus, Tubercle of, 68

Ventilation, 115, 173, 227
Viability of bacilli in sputum, 85
Vibert, 158
Victoria Hospital, Edinburgh, 189
—— ——, Rules of, 228
Villemin, 5, 6, 83
Virchow, 213
Voltaire, 167
Von Leyden, 218

Wales, H.R.H. The Prince of, 223
Walker, Dr. Jane, 190
Walters, 191, 192
Walther, of Nordrach, 175, 185, 197, 198
Wandering cells, 9
West Australia, 223
Wetness of soil, 124
Wilks, Sir Samuel, 160
Williams, Theodore, 213
Wind, 169
——, Shelters from, 171
Windows, Manipulation of, 227
Woodhead, Sims, 99, 102, 108, 109, 140, 145

Yacht as a sanatorium, 178

Ziehl-Neelsen method of staining, 15
Zoological Gardens, Experience of, 160

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